On the origin of pyaemia : a reply to the question suggested by the council of the British Medical Association, "Are there any trustworthy facts as to the origin of pyaemia?" / by Alfred Baker.

ON THE

ORIGIN OF PYÆMIA:

A Reply

TO THE QUESTION SUGGESTED BY THE COUNCIL OF THE BRITISH MEDICAL ASSOCIATION, "ARE THERE ANY TRUSTWORTHY FACTS AS TO THE ORIGIN OF PYÆMIA?"

BY

ALFRED BAKER, Esq.,

BIRMINGHAM.

[*Reprinted from the* British Medical Journal, *Dec. 8th*, 1866.]

LONDON:

PRINTED BY

T. RICHARDS, 37, GREAT QUEEN STREET.

MDCCCLXVI.

ON THE ORIGIN OF PYÆMIA.

The term Pyæmia implies pus in the blood; and it has been applied to certain morbid conditions of the system in which the circulating fluid has its constituents altered, and its distribution disturbed, whether these results follow its admixture with pus or with any other morbid agent.

Notwithstanding Piorry's statement that the blood itself is subject to inflammation, in which disorder pus-corpuscles were supposed to be intermixed in large proportion with the true blood-globules; Gulliver's imaginary discovery of pus-globules in the blood of persons suffering under typhoid diseases; and the subsequent declaration by Mayo, that pus-globules existed in the blood of every one; it is now believed that pus cannot be recognised in the blood by any known distinctive characters, and that the cells observed by these gentlemen, and mistaken for pus-cells, were really white blood-globules.

During the course of wasting diseases, especially if the lymphatic glands be affected, these white globules are often met with in considerable excess; and they are not infrequently too numerous in the subjects of pyæmia, although there is no necessary

connection between their presence and the occurrence of that malady.

Dr. Hughes Bennett drew attention to this condition of blood in a paper on Leucocythemia, and confessed that at first he mistook the white blood-cells for pus-corpuscles. Both he and Virchow agree as to the two classes of cells being precisely similar, and the latter author declares it to be impossible to distinguish them excepting by their mode of origin; he says: "If this prove to be external to the blood, you may safely conclude that it is pus; but if this is not the case, you have to do with blood-cells."

Piorry's supposition of a purulent condition of the mass of blood being thus disproved, it was suggested by Arnott, in explanation of the origin of Pyæmia, that it sprang from suppurative phlebitis; that the pus formed in the inflamed veins was carried into the circulation; and that the pus-globules, being larger than the blood-globules, became arrested in the minute capillaries, and gave rise to secondary abscesses.

To some extent John Hunter's views as to the identity of the anatomical structure, and inferentially of the pathological changes in veins, with those which are seen in serous membranes, gave colour to this theory. Regarding the veins as peculiarly liable to adhesive and to suppurative inflammation, he considered that discoloration of the lining membrane, a deposit of lymph on the surface, and the presence of a clot in the vein, which, whilst dark coloured externally, was frequently creamy and diffluent within, were unquestionable proofs of phlebitis. It is now known that these premises are erroneous; that ana-

tomically the lining of a vein bears no resemblance to serous membrane; that its discoloration is due to imbibition; that the supposed lymph is really solidified and adherent fibrine; and that the coagulation of the blood in a vein may arise from various causes entirely unconnected with the inflammatory process. With regard to the diffluent clot, upon which much reliance was placed, it has been examined by numerous histologists, and has been described by Gulliver as consisting of white blood-corpuscles shrivelled and altered, the remains of the red corpuscles, and the molecular *débris* of the fibrine-mesh holding them in suspension. The cells in the clot, looking like pus, are not the products of inflammatory action, but are pre-existing elements of the blood. These changes in the clot are retrograde and degenerative, and, as the centre of the clot is furthest removed from the vital force of living tissue, so the retrogression and softening are there most marked. Thus we see that Arnott's views of the production of pus and its conveyance into the circulation by the veins, are answered; whilst that part of them which supposed a mechanical arrest of the pus-globule in the capillaries, is disposed of by the identity of the pus and blood corpuscle as to size and other outward characters. Lastly, it may be added that numerous cases of plugging of the femoral vein by clot, with a puriform looking centre, are on record, which were unaccompanied by pyæmic symptoms.

It is now generally—though not universally—believed that the lining membrane of veins is rarely inflamed; that, when inflammation does attack it, the pathological changes are discovered in the coats,

and not in the contents of the vessel; and that the evidences of its presence are to be found in a cloudy opacity of the epithelial layer, and a fine elementary growth in the connective tissue; appearances utterly unlike those which are met with in serous textures after inflammation.

The doctrine of suppurative phlebitis and the consequent introduction of pus into the blood, is still, however, supported by men of acknowledged eminence. Dr. G. Budd and Mr. Holmes adopt it; and Dr. Bristowe considers phlebitis, idiopathic and traumatic, as a frequent cause of pyæmia. He declares that it has followed phlebotomy, operations on varicose veins, on piles, and the deligation of veins in other surgical proceedings; and he mentions the fact of pyæmia following the tying of the umbilical cord in a new-born child, presumably from phlebitis.

The 49th case related by Mr. Hodgson in his work *On the Diseases of Arteries and Veins*, supports this theory of the phlebitic origin of pyæmia.

"A soldier, aged 36, was bled in the arm for ophthalmia, which was considerably relieved by the operation;" but fever came on, with pain and swelling of the arm; the fever assumed the typhoid form; glandular swellings arose above the clavicle, and beneath the angle of the jaw; dyspnœa ensued, with delirium and death in the seventh week after the bleeding. On examination, "the cephalic vein, where it was punctured, resembled an artery in the thickness of its coats, and in retaining the circular form when cut across. Below the punctured part it was healthy. About one inch above, it was obliterated, and the obliteration extended to the shoulder.

The external jugular vein was less in size than the corresponding vein on the opposite side. The internal jugular vein was much enlarged, thickened and indurated; the effects of inflammation were apparent throughout its whole course; it had the external appearance of an artery, though larger than any artery except the aorta. The subclavian, axillary, and brachial veins to the bend of the arm, exhibited similar appearances. The external jugular and the subclavian veins were filled with pus; when slit open they were found to be much thickened, and lined with lymph; many of the smaller veins were in a similar condition; the lungs contained some small abscesses."

In this case, allowing for the altered pathological views of the present day, we have ample evidence of inflammation of the punctured vein, preceding, and apparently inducing pyæmia. In Mr. Hodgson's book, the record is followed by references to other instances of a like kind, related by Hunter, Abernethy, and Dr. Clarke. One source of doubt exists in the case quoted: it is this, whether the phlebitis was simple, or whether it was complicated by the introduction of some septic element into the blood through the medium of the lancet used in bleeding, to which, rather than to the mere puncture, the subsequent symptoms, local and general, may be attributed.

It is right to add that, whilst admitting Gulliver's description of disintegrated blood-clot to be in the main accurate, Dr. Bristowe maintains that *true pus* is occasionally met with in the clots of veins and arteries, and that pus is also sometimes discovered *in transitu* in the blood, not in the form of scattered

pus-cells, but in that of soft pellets consisting of pus-cells aggregated.

Before quitting the subject of the relation of the veins to pyæmia, let me object to the use of the term "absorption of pus by the veins," which has become general. It is opposed to all the teachings of physiology, which assigns no such functions to those vessels. The offices of absorption and renewal of the blood, in so far as these processes are independent of the lymphatics, reside in the capillary vessels, which appear to have the power of absorbing by their porous coats any gaseous, liquid, or minutely divided solid material that can pass through their walls. The operations of this system of vessels afford to my mind a much more satisfactory explanation of the production of some contagious diseases than the theory which attributed them to inflammation of the veins, or to the absorption by the veins of diseased secretions.

Take, for instance, the forms of puerperal affection, which are so intimately connected with erysipelas as to justify their being viewed as convertible diseases; and it appears to me that the majority of them are dependent upon the absorption of contagious matter by the uterine or vaginal capillaries. At first view, the unclosed orifices of the uterine veins and sinuses favour the idea of absorption through them; but though the orifices may be patulous, the vessels must be plugged within, or blood could not fail to flow from them; and the same barrier that wards off hæmorrhage, must surely form an adequate defence against any introduction into the blood by their canals of contagious material.

These affections are still attributed by many high authorities, including Sir J. Y. Simpson, to the absorption of some poisonous material by the veins of the uterus; but it is more probable that in many instances the uterus and its vessels are unconcerned in the process, and that it is due to inoculation of poisonous matter, through some abrasion in the vagina, by the finger of the attendant.

Mr. Athol Johnson published a case of pyæmia after amputation, in 1857, in which certain veins that had been tied were free from inflammation, and contained no pus; whilst those not included in ligatures were full of pus, and were much inflamed. This case is an argument against the opinions generally held as to the dangers of phlebitis after the tying of a vein; but, with respect to its value as supporting such a practice in order to lessen the risks of pyæmia, our estimate of it must perforce be small, since numerous cases of pyæmia are said to have occurred, in which every visible vein impinging upon the diseased or suppurating surface has been found closed.

In addition to the veins and capillaries, other blood-vessels may contribute to the production of pyæmia. It is established that atheroma or fatty degeneration of the arteries of the body may lead to arterial embolism, either by the escape of the fatty deposit itself into the blood, through a tear in the lining membrane; or by the detachment of the fibrinous deposit which so often covers these cracks of the inner coat, and the transmission of particles of it into the current of circulation. The emboli resulting from these substances have long been known to give rise

to curious and grave disorders; but they are believed also to occasion pyæmia. Dr. Bristowe has observed that the ultimate arterial twigs in lung and other textures (in cases of pyæmia) are distended by a soft pulpy yellow clot, which is composed of disintegrated fibrine and the *débris* of pus- or blood-cells: and from the fact that the changes observed in this fibrine required time for their production, he infers that arterial embolism was the first step towards the changes in the distribution of the blood, which ended in purulent deposits. His view is supported by analogical evidence, and by experiments made by Wharton Jones, Cruveilhier, Sédillot, and Mr. H. Lee.

An occasional, although infrequent, circumstance, in which pus and blood may be brought into admixture, is, when a vein or artery ulcerates under the pressure of an abscess. Cases of this rare kind are recorded by Pearson, Liston, and Miller. In an instance referred to by Miller, the ulceration was incomplete; the two outer coats of the aorta being thoroughly eroded, so as to leave only the inner coat entire, and in contact with an unopened abscess. These cases usually end fatally when the abscess bursts, by hæmorrhage into the sac of the abscess: but it is possible, as Mr. Liston argued, that a false aneurism may be the result. In any case it is not probable that a pyæmic state would be thus established; and no instance of such an occurrence has fallen under my notice.

It follows, from what I have stated, that pyæmia may result from phlebitis of a suppurative kind, although such a source of blood-disorder is believed

to be of infrequent occurrence; and that the same effects may be produced by embolism in the minute ultimate arteries, from chronic disease invading arteries of larger size. Of the relative prevalence of either cause we have no means of judging, but they constitute the only modes in which pyæmia can be produced by materials generated within the vascular canals themselves. In the introduction of foreign matters, whether hurtful or otherwise, into the blood, the capillaries have by far the most active powers of the whole system of blood-vessels.

There are other vessels, however, (the lymphatics) through which it has been thought that pus might enter the blood. We know that collections of pus, and of other fluids, disappear by a process which we call absorption; but it is uncertain whether the lymphatics or the capillaries are most active in their removal. It is certain, from the experiments of Tiedemann, Panizza, Magendie, and others, that the visceral lymphatics, or lacteals, exercise a selection or choice in the materials absorbed by them, and that they take up injurious substances slowly, and as it were unwillingly. The peripheral lymphatics, on the other hand, will absorb poisons readily, and carry them into the blood. Even with them, proof of the absorption of pus is wanting; and, granting them this power, it is very improbable that the pus absorbed reaches the blood in the same form. The structure of the lymphatic glands, according to Kölliker, is such as leads to an interruption of the current of lymph brought by the afferent vessel; to its filtration in the parenchyma of the gland, and the separation of corpuscular and other elements from it, before the

digested and purified lymph is sent on towards the blood. When anything received by the gland cannot be digested by it, inflammation and suppuration are said to be established in the effort to extrude it. Ricord's description of syphilitic bubo is an admirable illustration of this process. He states that suppuration occurs in the inguinal glands in two situations: in the centre of the gland where the matter is syphilitic and inoculable, and on the exterior where the pus has no specific properties.

From the changes in character and composition effected in every particle of matter, during its passage through the lymphatic vessels and glands, it almost necessarily follows that pus loses its peculiar characters before being received into the blood, and that, in the shape of pus, it cannot enter into the circulation by the agency of the lymphatics.

Having thus glanced at the channels through which pus may possibly enter the blood, the next inquiry is whether pus, having gained entrance into the blood, can be recognised in that fluid, or can lead to the development of those formidable symptoms, grouped together under the term pyæmia.

It has been asserted, on the strength of the absorption of collections of pus being frequently unattended by serious constitutional disturbance, and on other inadequate grounds, that pus is not poisonous; whilst, on the other hand, cases of pyæmia are recorded, which are traceable to no other discoverable cause than absorption of pus. Lebert, Sédillot, Dr. Hughes Bennett, Mr. J. S. Gamgee, and others, have proved by experiment that pus may be injected into the veins of the lower

animals, that it mixes readily with the blood, and becomes so incorporated with it as to be indistinguishable. In one of Dr. Bennett's experiments, in which he had exposed six inches of the jugular vein of an ass, before injecting the pus, "owing to the transparency of the vein, the yellow opaque fluid was seen to join the blood, to continue for a few moments running side by side with the crimson current, until at length the vein became full of pus. On removing the syringe to obtain a fresh supply, the blood above could be seen to join the pus, to continue side by side with that fluid, presenting a streaked red and white appearance, without any coagulation, until all the pus was carried forwards and downwards towards the heart, and the vein was again full of blood." A second syringeful of pus was then injected with similar results. No local or constitutional disturbance followed, and when the animal was killed four days afterwards, the vein was found pervious.

So many writers have proved the facility with which pus is injected into the veins of living animals, without inducing any signs of coagulation in the blood, that we are compelled to infer the existence of something unusual in those experiments performed by Mr. H. Lee, from which he was led to believe that pus introduced into a vein coagulated the blood and arrested the circulation in it so that the pus became encapsuled, and was thus prevented from entering the moving current. This effect may have been due to the qualities of the pus employed by him, or to the condition of the animal subjected to the experiment. With reference to the power of pus thus introduced into the blood of living animals, to produce pyæmia,

we find testimony of a discordant kind from the same observers; thus Lebert, Sédillot, Polli, and others, have sometimes succeeded in inducing pyæmia by injections of pus into the veins; at other times they have failed. Indeed, the trials made by the same operator with pus believed to possess the same qualities, have led to results so dissimilar, as to render it impossible as yet to arrive at a positive conclusion. It has been proved that fresh pus may circulate in the living blood of the lower animals without appearing to excite any important symptoms of disordered health; but this does not disprove the existence of local mischief, and, from the reports which are published, I am led to the conclusion that, in the majority of cases, when the animals were killed after pus had been injected into the blood, circumscribed congestions were found in the lungs, and other organs, which corresponded with those that are known to constitute the earlier stages of the secondary abscesses, so characteristic of pyæmia; whilst in some of them, and especially in those instances in which the animal had been subjected to repeated injections, puriform collections were actually found after death.

Whether human beings would bear the introduction of pus, however fresh, into the blood without severe, if not fatal constitutional disturbance, is an open question; but the cases which are on record do not indicate such a tolerance. In his medical report on contagions and septic diseases, made to the Privy Council, Mr. Holmes says "there is no valid reason for doubting that purulent infection of the blood, accidentally arising, in human beings, is the

essential cause of pyæmia," and he mentions a most curious and interesting case, bearing on this question. He states that fatal pyæmia was induced by the bursting of a small mesenteric abscess into the thoracic duct, and the direct transmission of pus to the right side of the heart. This case appears to possess every essential point for the settlement of the question; since the abscess, being internal, and shut off from communication with atmospheric air, would probably contain fresh untainted pus.

Mr. Holmes also refers to another remarkable case, published by Mr. Bowman in his *Lectures on the Eye.* A young gentleman died from pyæmia, following ulceration of the mitral valve of the heart, where perhaps, there had been a small primary abscess. This case, however, is less conclusive than its predecessor, because the existence of abscess is assumed, and the pyæmia may be accounted for on Virchow's mechanical theory, by the detachment of a small mass of fibrine, with which the valve was covered, and the obstruction by it of the capillaries, as an embolic body. The case was one of amaurosis, accompanied by old standing rheumatic peri- and endocarditis; a condition with which the so-called idiopathic cases of pyæmia are not infrequently associated or confounded.

There is ample ground in the statements which have been made, for the suspicion that the entrance of pus into the blood of human beings is one of the causes of pyæmia. At present we cannot estimate the frequency of this cause, nor can we determine dogmatically the modes in which pus gains entrance to the blood, or the process, zymotic or otherwise, by

which it induces the symptoms and pathological changes which attend that disorder. With regard to the latter point, it has been suggested that the pus-globules may disorder the blood in some subtle manner, causing its fibrine to separate here and there in the capillaries, thus inducing that obstruction to circulation which precedes textural disintegration and secondary abscess.

Whilst admitting the facts already adduced, there can be little doubt that other causes are brought into operation in the production of a disease so variable in its course: and we may now profitably revert to those thrombi or coagula in the veins of which I have already spoken, and which Hunter and Arnott regarded as the products and proofs of phlebitis. The tendency of the blood to coagulate in these vessels appears to be traceable to mechanical injury of a vein, to irritation of its lining membrane, or to a morbid condition of the blood itself. Upon the changes which take place in these clots of blood, Virchow has attempted to reduce the heterogeneous evidence on the causes of pyæmia to order: he has offered and ably argued an ingenious explanation of the constitutional disturbance, and of the pathological effects which attend pyæmia. He starts with the assertion that thrombosis in the larger vessels is the first step towards the formation of the secondary deposits; that these thrombi after a time disintegrate and crumble down; and that the separated portions are carried by the current of blood into the capillaries, where they become wedged, and form what he calls "embolia," around which congestion and stasis of blood is estab-

lished, followed by capillary phlebitis and abscess. He also expresses an opinion that the character of the secondary deposits depends upon the changes which take place in the original thrombus. Thus, if the softening of the thrombus be of a gangrenous nature, so will the secondary deposits be gangrenous also; whilst, if the original thrombus contract, and be converted into connective tissue and pigment, the secondary embolia will waste and disappear. In the latter case it is known, from the effect of various agents which have been found to induce local coagulation of the blood, such as solid molecules of blood, disintegrated fibrine, or fatty matters arising out of the conversion of pus-cells, that the embolism is frequently unattended by pyæmic symptoms.

Thus far Virchow supplies us with an intelligible and probably accurate history of certain forms of pyæmia, arising from the degeneration of a thrombus or blood-clot; but many cases of pyæmia that we witness pursue a course so rapid and fatal, and display evidences of such severe shock, and nervous depression from their commencement, that they resemble the worst cases of typhus, scarlatina, erysipelas, and other asthenic fevers. To the production of these cases, the tardy retrogressive changes in a blood-clot would appear to be *per se* quite inadequate. Another agent must be assumed, capable of disordering the mass of blood; and in explanation of these severer forms, Virchow asserts that certain putrescent fluids, having no necessary or direct relation to pus, and which differ in their nature and origin, are absorbed through the agency of the lymphatics, and induce a dyscrasia, under which in-

fluence their effects are acutely exerted on organs which have a predilection for them. He calls this form of malady "Ichorrhæmia or ichorous absorption," and states that the blood-mass is rapidly contaminated by the poison; that the congestions and inflammations which follow are diffuse, instead of circumscribed, as in pyæmia; and that they are almost uniformly fatal.

To Virchow's ingenious theory of simple embolism as the immediate cause of pyæmia it has been objected, that uncomplicated embolism is followed by fewer centres of congestion and stasis than we see in pyæmia; that the area of each spot is wider; and that the stasis which results from simple embolism is less likely to be followed by degenerative softenings; Dr. Bristowe asserts also, that this embolic theory is only partial in its applicability, since it does not explain cases starting from some part of the systemic venous system, in which the lungs escape, whilst secondary deposits abound in other organs.

Dr. Wilks, who is a staunch advocate of the origin of pyæmia in pus, upon the ground that "like produces like," entertains an opinion similar to that of Dr. Bristowe. He says: "When a few lobules of the lungs are inflamed, the fatal results cannot be accounted for, either from the amount of disease in them, or from the constitutional disturbance resulting therefrom; and we must have recourse to the blood-disease itself, and its effects on the system and nerves, to account for the event. If it be true that death may occur independently of the local disease and its effects, it is not difficult to understand how the same result may be brought about without any

visceral affection whatever, and we have no doubt that this is very often the case."

As bearing upon the doctrine of thrombosis and secondary embolia, Mr. Lister and Dr. Mackenzie have advanced the opinion that anything which irritates without inflaming the lining membrane of a vein, favours coagulation of the blood in it; and Dr. Mackenzie has experimentally induced obstruction of large primary venous tracks, by irritant injections (allowed to escape before the blood was re-admitted), after which the secondary circulation became obstructed. Whilst these experiments of Dr. Mackenzie support Virchow's theory of thrombosis and consequent embolism, they can scarcely be accepted as proofs of coagulation of the blood in a vein, through simple irritation of its internal coat, inasmuch as minute portions of the chemical agents employed (lactic acid and oxide of zinc) may have remained upon the lining membrane, and have produced coagulation by their presence.

We have now briefly reviewed the more prominent facts and theories concerning the origin of pyæmia, and I have attempted to lay clearly before you the causes which may operate directly in its production as a disease uncomplicated by any special septic agency. The records of cases which have occurred, afford sufficient ground for Bennett's and Virchow's opinion that this disease is, under certain circumstances, associated with septic or putrescent contamination of the blood; and this may be admitted without hesitation, since our latest authorities declare that pyæmia, in common with erysipelas, phagedæna, and gangrene, is apt to occur when the surface of a wound is foul;

when dead particles are in course of separation from it; and when effused blood is putrefying under the influence of atmospheric air.

There can be little doubt, from experimental researches, that the variance in the pathological changes found after death in animals, has been influenced largely by the agent injected, and by its degree of putrescence; thus Dr. Weber and Professor Panum declare that filtered putrid fluids and sulphuretted hydrogen never cause infarctus, or metastatic abscesses: these only occur when morphological bodies, of small size, but sufficiently large to obstruct the capillaries, pass into the circulation. They infer that the disease usually called pyæmia is septic poisoning, *plus* some element capable of leading to embolism.

Concerning the nature of the special agent of putrid poisoning, we are uncertain. Professor Panum declares it to be fixed, not volatile; indestructible by boiling and subsequent evaporation to dryness; soluble in water, insoluble in alcohol, and so intense as to be comparable only with the poison of serpents, curare, and the vegetable alkaloids: whilst Dr. Richardson, at a recent meeting of the Epidemiological Society, announced that he had found the poisonous matter of pyæmia to be an alkaloid, which was derived from the decomposition of albuminoid substances. He calls it "septine," and says that it has the power of transforming albuminous secretion into matter like itself.

From what has been already said it is scarcely necessary to state that the secondary, or metastatic abscesses, which occur in pyæmia, have been repeatedly

and jealously examined; and that they are found to consist of the elements of the blood more or less modified, granular matter, exudation-corpuscles, granule-cells, and not infrequently true pus-cells. Sometimes they have a gangrenous odour, and contain shreddy particles, which are infiltrated with a dirty looking fœtid puriform fluid. It has been thought that the presence of these abscesses might be viewed as a crucial test of pyæmia; and it is true that in most cases they exist; but they are not constant. Their occasional absence may be explained by a theory which Dr. Williams has proposed to account for rapidly fatal fevers, that have presented few pathological changes; viz., that a fatal result is brought about, from the intensity of the poison, in too short a time for the usual series of pathological actions to develope themselves; and Mr. Lee declares that in several instances of fatal pyæmia he has "been unable to trace either blood-clots, or metastatic abscesses."

Whatever may have been accepted at various periods, as the ultimate cause of pyæmia, the frequent occurrence of its symptoms after local injuries and surgical operations, has led somewhat naturally to the supposition that a wound of some kind was an essential precursor. Admitting that injury involving local suppuration is a very frequent preliminary, it is certainly not an universal one. Numerous cases have been published which presented unquestionable symptoms and *post mortem* appearances of pyæmia, in which no local disease or injury was traceable. Jenner relates cases of typhus terminating in "pyogenic fever." Tessier speaks of in-

stances of "acute purulent diathesis," which were developed spontaneously; and Bennett, Gamgee, and others, have published cases of this malady succeeding upon what appeared to be acute rheumatism.

In explanation of these spontaneous occurrences of pyæmia, it has been assumed by many surgeons, that some intermediary disease, such as necrosis, may be established, as a consequence of the primary affection, and that by the absorption of noxious materials from the diseased part, the blood may become poisoned. Allowing to this suggestion its due weight and value, there can be no question that, whilst pyæmia occasionally shows itself as an idiopathic affection, it is far more frequent in surgical than in medical practice; and that it is more prevalent after certain wounds and injuries than after others of a different description, and involving different textures. Diffuse asthenic inflammation of the cellular membrane, phlegmonous erysipelas, and their allies—carbuncle and dissection wounds—are extremely liable to be followed by pyæmia. Unhealthy inflammation, situated in the deep cellular tissue around a bone, or in its interior; diseases which are calculated to induce necrosis, may be accounted as very frequent precursors. Mr. Holmes says that the risk is greater when such inflammation attacks cancellous bone; and this remark applies not only to injuries, but to operations, such as amputation, and the excision of joints. In this opinion he is at variance with Mr. Syme, who has strongly recommended amputation through the cancellous ends of long bones, on the ground of its being attended with less risk of pyæmia than when the bone is divided in the denser part so as to lay open

its medullary cavity, and has supported this position by numerous published cases.

It may be remarked here, whilst speaking of amputations, that the relative frequency of pyæmia is greater after primary operations, than after those performed for chronic disease; and this has been attributed to the more frequent occurrence of inflammation of the veins in these cases. Phlebitis is held to be an occasional cause of pyæmia by all pathologists, and by some it is considered to be a frequent and chief cause. A remark made by Dr. Bristowe on this point, will show how strongly this view is entertained by him. He says: "If the presence of phlebitis is to be denied in all cases where there is an absence of thickening and congestion of the venous walls, it may with equal justice be denied that bronchitis has been present, when the bronchial mucous membrane is found after death neither congested nor thickened; but in many cases of fatal bronchitis the mucous membrane itself looks quite or nearly healthy."

Suppurations in the eye and ear, and in various parts of the genito-urinary organs of both sexes, are also considered to be a common cause of pyæmia: but no injury, from a simple contusion to the most severe crush by which the component textures of the part are at once devitalised, can be said to enjoy an immunity from its possible invasion. From observation it appears that, in recent wounds, some deviation from the healthy reparative action must precede its attack; the surface must become sloughy and foul, with a tendency to putrefactive destruction of fibrinous matters and blood-clot; a condition in which

fermenting and septic matters are formed quickly and abundantly, and, unless these be frequently removed, they must become a source of extreme danger.

It has long been supposed that certain atmospheric conditions have exerted considerable influence in the production and spread of pyæmia and other contagious diseases. It is probable, however, that in most of these surgical maladies a direct conveyance of contagious or poisonous matter is the real mode by which they spread: and that air vitiated by the respiration of many human beings, by exhalations from their bodies, and by effluvia from discharges and excretions, merely renders the patients, by depressing their vital power, more prone to the attacks of zymotic disorders, and less able to resist their ravages.

It is known by actual experiment, that the quantity of organic matter floating in the atmosphere, and adhering to the walls and furniture of sick wards, is immense; that much of this is putrescible; and that it may, therefore, form a medium of contagion. In the Foundling Hospital at Répy, an epidemic of ophthalmia was traced to particles of pus floating in the air. Recent investigations by Chalvert, Moscati, Dundas Thomson, and others, have led to the discovery of countless living germs of vegetables and infusoria—mycoderms, mucedines, torulæ, vibrios, and bacteria—in atmospheric air, capable, when supplied with a suitable menstruum, of establishing the processes of fermentation and putrefaction. Some of these germs, inappreciable to our unaided senses, find their most appropriate

nourishment in the secretions of wounds, or in pus. Schrœder and Pasteur have asserted that different chemical changes are wrought by different germs. They say that "the bacteria may enter the blood, absorb its oxygen, hinder the combustion of effete substances which should be eliminated, and work deadly changes in the circulating fluid." Dr. Lionel Beale, in his researches into the sources of the cattle-plague, appears to have arrived at conclusions in accordance with those just mentioned. He is of opinion that the *materies morbi* of contagious diseases consists of minute living germs, which may be conveyed by air, are intercommunicable between man and animals, and are not readily destructible.

If these views be confirmed by additional enquiries and experiments, they will form the basis of a new and animalcular theory, explanatory of the propagation of many diseases. At present, however, our knowledge is insufficient for the deduction of any laws governing their production and their increase; so that we cannot yet suggest any useful precautionary measures as a special defence against these invisible plagues, and we must trust to those well known hygienic rules which are essential to the health of all of us, and which are most stringently required to be carried out in the construction, superintendence, and arrangements of large buildings designed for the occupation of the sick.

Before concluding this imperfect sketch of the known and probable sources of pyæmia, I must say a few words in reference to those causes which have been said to predispose to its establishment. It has

been repeatedly affirmed that the impure air of hospitals, in which many patients with wounds are treated, and which has been recently termed a "traumatic atmosphere", acts as a predisposing cause; and the mortality from traumatic pyæmia exhibited in Mr. Bryant's statistical tables is a very strong argument in support of this opinion. It has also been declared that morbid conditions of health engendered by injurious occupations, by dietetic excesses, and by bad habits of life, dispose the blood to decomposition from trivial causes, whilst they lessen the resisting and reparative powers of the body. What the changes in the blood are, chemistry fails to discover; but histologists tell us that its fibrine is deficient in quantity and in contractility; and that there is a relative increase in the albuminous and fatty matters contained in it. Dr. Chevers, especially, is disposed to attribute the access of pyæmia after surgical injuries to morbid conditions of the organs of assimilation and excretion within the abdominal cavity; and he has stated that, in the absence of injury or operation to form the starting-point of pyæmia, many of these persons would have been cut off by fatal cerebral, thoracic, or abdominal disease. We cannot help acknowledging the force of such opinions, because they are consistent with the approved doctrines of hygiene and physiology; but, whilst admitting this, we must not attach undue weight to them. So many facts can be advanced against them as to materially diminish their seeming importance. It is known that a considerable number of cases of pyæmia originate in large towns, in the close and crowded dwellings of the poor, and are thence im-

ported into the hospitals; whilst the more airy and well-constructed dwellings of the wealthy do not escape this scourge. Dr. Bristowe is entirely opposed to the opinion of Dr. Chevers, and asserts "confidently that the vast majority of pyæmic patients have not been suffering from chronic visceral diseases, few from acute; and that very many victims of pyæmia have enjoyed excellent health up to the moment of the injury, operation, or disease which has exposed them to its risks." Mr. Quain also relates four cases which shew forcibly how open Dr. Chevers' opinions are to objection. They were patients upon whom amputations had been performed; they were placed in wards with good ventilation, not overcrowded, and which had been recently cleaned. Two healthy males died of pyæmia, and two unhealthy females recovered. One healthy male took food well even after rigors set in, yet died. One unhealthy woman vomited all food for three weeks, and yet finally got well. Mr. Quain also refers to a boy admitted into hospital with pyæmia following a bruise on the knee, who died in two days; and says he was brought in from a healthy district, from good and well-ventilated lodgings, was well fed, and had been quite well up to the time of the accident.

T. RICHARDS, PRINTER, 37, GT. QUEEN STREET.