On the treatment of the bites of rabid animals, being a record of 15 successful cases, by

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During a residence of nearly six years in Bengal as a medical missionary I have had unusual opportunities of meeting with, and treating Natives of India who had been bitten by Rabid animals chiefly dogs and jackals; and it is the mode of treatment I adopted, and the results which followed that I desire to make the subject of this thesis.

How I began to use the permanganate of potash

As early as 1878, and towards the end of that year I began to use the permanganate of potash for open sores, but I had only adopted this method after finding the Carbolic acid treatment both expensive and inconvenient, and under the circumstances, ineffectual. What I refer to is that it was ineffectual when used in dressing open sores of outdoor patients, in a tropical climate, who could only be seen by me once in three days. I found that when I used the Solution of Carbolic acid for ulcers, wounds, burns, and open abscesses

and

protected the dressing with the tender cool leaf of the plantain tree — an admirable substitute for oiled silk — it evaporated so rapidly on account of the great heat of the surrounding atmosphere that the dressing would become dry in a few minutes, and its antiseptic properties lost. I then used Carbolic oil, but although it gave me better results it did not withstand the drying influence of the sun and heated atmosphere. This will be better understood when I state that I had no hospital and my patients were consequently obliged to return to their homes — in many instances miles away — after they were dressed, and that under a burning sun. Many of these patients were peasants who worked in the open field all day. To let them return to their homes with a single dressing under these circumstances would mean practical failure to cure them, and to give them three days supply of Carbolic oil meant an

expenditure for which the slender income of our mission dispensary was not prepared.

How and why I adopted the Continuously moist method

Under these circumstances I began to cast about for some efficient antiseptic substitute, which would meet all my requirements. I remembered having the dressing of an interesting case of periostitis of the tibia in a little girl in Dr McLeod's wards in the Western Infirmary, and she was almost entirely treated with the permanganate of Potash dressing. The progress of this case was so rapid and satisfactory that it impressed me greatly. I no sooner found myself facing the above difficulty than it immediately occurred to me as a suitable substitute. I however found that the permanganate solution evaporated as rapidly as the Carbolic solution, and that its antiseptic properties were even more completely lost than those of the Carbolic Acid, when it had dried. I however knew that the cost

of permanganate was very little compared with Carbolic acid and I could therefore use it almost in any quantities, without increasing the dispensary expenditure. I therefore decided to try and keep the dressing always moist. In adopting the Continuously Moist method I had two objects in view (1) to prevent air getting at the surface of the wound, as far as possible, and (2) to keep the Wound always in Contact with a mild stimulating antiseptic dressing, which would not hinder the healing process, or injure the tender granulations. To accomplish this I not only saturated the lint with a weak solution of permanganate sufficient to give the water a deep purple colour — but also the bandage covering the lint, which I rolled on wet, thus securing exclusion of air from the surface of the wound. The bandage being firmly applied in this moist condition

and kept so, day and night, by the patient who was supplied with a quantity of solution sufficient to last until he returned to the dispensary, no air reached the surface of the sore; or if it did, it was neutralised by the continuous moist condition of the wound and the dressing. He was instructed how to open the bandage and redress the ulcer or wound every morning at his home; to come back on the third day for a fresh supply of the solution, and to show the condition of the wound. This treatment gave me admirable results; and it was while carrying it out that the first case of mad dog bite, which I record below was brought under my care.

Case I A mad dog bite

A little girl 9 years of age from a neighbouring village was brought to me by her mother suffering from extensive laceration of the scalp. I learned from the mother that her little daughter was playing near her hut when a strange mad dog attacked the child and knocked her down wounding her

scalp severely. This dog, when driven off, attacked another dog belonging to the village. I was alive to the great danger of hydrophobia, but found, however, willing I might be, that the injuries were so extensive as to forbid the use of strong Caustics or excision, or even the use of Nitrate of Silver. I therefore prepared a Strong Solution of Permanganate of potash 8 Grains to the Ounce of Water, and washed the whole of the torn scalp & pressed every scratch I could see, so as to allow the Permanganate Solution to enter into the wounds thoroughly. This was at least 24 hours after she had been bitten by the dog. The child came daily and was dressed, and as far as possible it was in the <u>Continuously moist method</u>, but this could not easily be done on the head. The case went on favourably and healed in due course without a bad symptom. Meanwhile the dog which had been

bitten ~~was~~ became rabid about the 16th day
This alarmed the parents of the little girl, who now
expected every moment that their daughter would
manifest symptoms of hydrophobia; and
although I was myself as apprehensive
as the parents no symptoms appeared and
the little girl is now grown up and is probably
a mother.

I naturally asked myself the question—
Why has this child not manifested
symptoms of hydrophobia? Is it because
the dog was not mad at the time of
inflicting the bites? surely not, for then,
why did the ~~the~~ dog bitten at the same time
go mad? If the animal then, was really
in a rabid state, why did not the virus take
effect? To this latter question I could
suggest only three answers (1) The virus
may have been washed out by the bleeding
and subsequent suppuration, which

accompanied the healing process; or (2) it might not have entered the wound at all; or (3) it might have been rendered innocuous by the oxidising properties of the permanganate of potash.

The first and second answers under other circumstances might have been of weight; but in this case I felt more inclined to look upon the permanganate in some way as the cause of his escape. I therefore determined to follow up the treatment in the next case that came under my care; for only by such means could I clear up the question as to whether the permanganate was of any practical value as a prophylactic of hydrophobia when applied to the bites of rabid animals.

I had not long to wait, for the apparent

success of this case soon spread from village to village, and a Mohammedan boy aged 17 years was brought to me by his father in the beginning of 1880. This lad had been attacked by a mad dog when he was "saying" his prayers on the bank of a tank near his father's house. The dog seems to have approached him from behind when he was on his knees, and bit him on the leg: he at once turned round, but having no stick in his hand he was obliged to fight the dog, which persistently clung to him until he strangled it. He came to me about 24 hours after, and was so severely bitten in so many places that it was out of the question to think of excision, cauterizing with a hot iron, or using strong nitric acid; and to apply nitrate of silver would be to use an agent in which, from the experience of others, I placed no confidence. Besides, the last case

Case II
A mad dog bite

encouraged me to apply the permanganate which I did, having opened every scratch and incised wound carefully, so as to allow the solution to get into every part; I dressed with the Continuously Moist Method. He came daily to be dressed and ultimately made a good recovery, notwithstanding the evil prognostications of many of his friends. The boy is still well, and the case occurred 4 years ago.

I was thus again encouraged to believe that there was some efficacy in the permanganate.

Cases III and IV mad dog bites

My next two cases were to me most anxious ones. I had a little pup not a year old which had been bitten by an undoubtedly "mad "pariah" dog. I shot the "pariah", but kept the pup in order to see if he would become mad, and if so, how long after the bite? He was kept tied up and fed as usual,

but my servants were warned not to approach too near him lest he might bite them. About fourteen days after, the servants seemed to have forgotten my injunctions, and as the creature was naturally quiet and docile, they passed and repassed near him not expecting that he would bite them; but one day he suddenly snapped and bit two of my new servants in quick succession. It was only then, my attention was called to the animal, which I found salivating, snapping at the air, biting his hind legs, and the rope with which he was tied. I shot him immediately after; but felt very uneasy knowing that I was in some measure to blame for not destroying the animal before he had bitten my servants.

The first who was bitten was my "bearer" or personal servant a native christian. He was bitten on the leg[illegible], and the wound was a deep incised wound made apparently by the incisor teeth, which were very sharp in so young an animal. I opened up the wound with great care making sure that no part of it escaped the permanganate solution. This case healed in a few days and he was with me for nine months after this happened. He afterwards went to Calcutta where doubtless he still remains.

The other manservant, a hindoo, bitten by this same pup received an abrasion on the right leg over the anterior lower third of the tibia. He too was treated in the same way, and being my

groom is still in my service in India.

In these two cases I had no doubt whatever that the animal was suffering from rabies at the time it bit these men; and it is therefore, to say the least, remarkable that they were entirely free from any symptoms of hydrophobia.

Case V Mad jackal bite.

This was a hindoo "Chuprassie" or Office messenger connected with the government offices near my house. He had, according to native custom, gone out in the early morning in obedience to the call of nature, to an adjoining field, and while there, was attacked by a mad jackal, and bitten in the right leg. He came to me about six hours after he was bitten, and was dressed and attended to in the same way as the previous cases, followed up with the continuously moist method until

the wound healed. This man made good recovery, and was under observation for about one year and a half, during which time he showed no indications of hydrophobia, although he was kept in a state of constant mental agitation by the running comments of his friends who assured him he would not escape, but would become mad like others who had been bitten by mad jackals.

Case VI
A mad jackal bite

The subject of this bite was an old man, a hindoo about 60 years of age. He was watchman at the government offices, and was attacked by a mad jackal on the high road and bitten on the leg. I saw him a few hours after he had been bitten, and treated his wounds as I had treated the former cases. He made a good recovery and was under observation for about one year

after which I lost trace of him.

Case VII Mad jackal bite.

A hindoo musician living in a village not far from my house, came to me in great excitement with his leg covered with blood. He had been sitting in the rays of the early morning sun warming himself when a mad jackal rushed at him and bit him in the leg. This man was very nervous, and apprehensive of hydrophobia. I continued the permanganate treatment as in previous cases, and he was well when I left India, a year after the bite. I often met him on the road during that time, and he always regarded me with superstitious veneration as his preserver.

Cases VIII/XI Jackal bites

Here we have four cases which may be grouped together. In a village a few hundred yards from my house, a mad jackal attacked a goat tethered near one of the huts. The grandmother of the

household hearing the Cry of the goat came to its rescue, and the jackal turned on her and bit her. She screamed aloud, which brought her daughter-in-law to her aid, who in turn was bitten by the jackal. Next a young man who came to their help was bitten also, and the jackal then disappeared in the jungle behind the village. The Son of the old woman came hurriedly in from the field where he had heard of the calamities which had befallen his mother and wife, and foolishly went in search of the mad jackal. He had not gone far when he saw the animal which he recognised as mad approaching the village again and coming towards him. He raised his bamboo Club in order to deal the animal a fatal blow, but missed his stroke and the infuriated brute rushed on him, seizing him by the

leg and was with difficulty shaken off and killed. These four victims were patients of mine and their wounds were treated in the same way as the previous cases. They all did well, and were in perfect health until I left India nearly a year after they had been bitten.

Case XII A mad jackal bite

This man was a Mahommedan peasant or "Ryot" who lived some few miles from my dispensary. I saw him two days after he had been bitten by a mad jackal and as his wounds were crusted over I opened them up carefully, and applied the permanganate as before. He did well, and I never heard of his illness or death up to the time of my departure, 9 months later, although I frequently inquired about him from others who came from his village.

Case XIII A mad Jackal bite

This man - a boatman on the Ganges - was bitten by a mad jackal on the highway. He too did well, and was under observation afterwards only for a few months, after which time I lost sight of him.

Case XIV A mad dog bite

A Mohammedan peasant bitten by a mad dog. I saw him about twenty four hours after he was bitten - Opened up his wounds, dressed them as usual with the permanganate, and he has never had any symptoms of hydrophobia. He was under observation for Six months or more.

Case XV. A mad Jackal bite

This case was a Mahommedan peasant seen on tour at a distant village. He was bitten by a mad Jackal, and was well, I heard, six months after the bite.

These cases were not the only ones that came to me during these years: there were probably six or eight cases more of bites of rabid animals which were treated, but they never returned, nor could they be traced without a great deal of trouble. I have disregarded these altogether, as they could not be regarded as satisfactory evidence in our present inquiry.

Remarks on the above Cases

It will at once occur to anyone who reads the above record of cases that, under such circumstances, where we have so many elements of uncertainty mixed up with the observations, any deductions based on such unreliable evidence must necessarily be, to say the least, misleading. And on that account it will be asked, "why were not these observations brought to the test of actual experiments on living animals at

the time, and on the ground where such facilities were at hand? No one can regret it more than I do that this question of the efficacy of the permanganate of potash treatment, was not brought to the test of experiment on animals, two years ago; for I had seen, all along, that only by this method could it be satisfactorily settled. I was on the eve of beginning experiments — in which I hoped to have the assistance of Her P. Bridel teacher of Chemistry in the Rajshaye College, — when I was stricken down with intermittent fever and was obliged, much against my will, to leave for Europe at once, in order to save life. Under these circumstances this important investigation was put aside, but I trust I may yet be able to resume it, and demonstrate the truth or error of the theory I am advocating in this thesis.

In order however to make the most of the material in hand it may be asked (1) "How far are these cases reliable?" (2) Ought we to attribute the success of these cases to the use of the permanganate of potash?

I

How far are these cases reliable?

(1) How far are these cases reliable? In the majority of the cases recorded we have to rely wholly upon the statements of the patients and their friends as to the condition of the animals at the time of inflicting the bites. Thus, in Case I, we have only the evidence of the child's parents and friends as to whether the dog was mad or not; and indeed, under ordinary circumstances perhaps no less reliable source of evidence could be called into Court than the statements of a Bengal Ryot. In this case, however, we have not to deal with evidence that can be classed in the same category with

the ordinary Court evidence extorted under the terrors of the Penal Code of India. We have simply to deal with a fact of observation, and to ask ourselves if in this case the Ryot may be considered a competent and reliable witness? That I consider him reliable in this case will appear from the following remarks. We have two facts which do not admit of doubt—(1) that the child was bitten by a dog (2) that the same dog was afterwards observed attacking one of the village dogs. The parents were quite alive to the necessity of giving a correct discription of the nature and cause of their Child's wounds, for every villager believes that the European doctor has a certain drug or remedy which is only suited for one kind of disease: and if he desires to be cured he is painfully minute in describing what he believes to be the cause

of the disease, in order that the doctor may recognise the disorder and apply the proper remedies. It is therefore evident that, in a case of this kind where so dreadful a disease, with which they are, alas! too familiar, in men and animals hangs over the patient, they would be careful to give, as far as they knew, the real cause of the wounds. As to whether the evidence of a Bengal villager on the Condition of the dog is reliable or not, it would be perhaps more in accordance with our experience of such a witness in this country, to dismiss the evidence as unworthy of serious consideration, especially on a point which has sometimes misled experts. The Bengal peasant, however, though far behind his European Confrere in most things is not so in this matter, for mad dogs and mad jackals are seen prowling about his homestead daily. He is familiar with sights and sounds of rabid animals from

the Cradle to the grave. He knows the appearance of the rabid animal even in the premonitory or early stage of the disease when it is retiring, with drivelling saliva, and seldom aggressive, as well as the irritative or second stage when it is aggressive and attacks both man and beast. And almost every boy in the village understands the significance of the third or paralytic Stage when the wretched animal is staggering along the roadside, or Crouching in drains or "nullahs" in search of some quiet, dark, secluded corner where he may lie undisturbed with drooping jaw and Swollen tongue hanging from his mouth, until death relieves his Sufferings. It has often surprised me how observant my servants were on these points. Having told them on no account to allow a rabid animal to Come near our house

without letting me know, they invariably apprised me when one came near; and I am not aware of one single instance in which they were wrong in their observation. Thus it seems to me that, strange as it may appear to us in this Country, the ordinary Bengal peasant is a competent witness to say whether a certain dog or jackal is mad or not; and when we have the testimony of one, corroborated by many as in Case No. I there seems little room for doubt as to the condition of the dog. But in this Case we have the additional conclusive evidence of the village dog which had been bitten having gone mad after 14 days. This important fact gives the whole evidence a definiteness and completeness leaving little to be desired.

In case II the evidence though not so conclusive as in Case I clearly points to the rabid condition of the animal

at the time of attacking the lad.
This boy was himself intelligent above the
average, and his testimony, with that of other friends, goes to
prove that the animal was mad. The circumstances
surrounding the incident are worthy of
attention, as supporting this view. The boy,
in the calm attitude of prayer, the place,
an open elevated space on the bank of a
tank, where dogs would rarely stray in
any place
search of food; not near a house, or where
the lad might be considered by a domestic
animal to be trespassing; nor was there anything
in his dress or manner likely to provoke
the animal. Then again, the persistent
determination of the dog to continue
the attack, marks it out as destitute
of fear. All these circumstances considered,
leave little room for doubting that the
dog was suffering from the "furious"
form of rabies, at the time.

In regard to Cases III and IV who were bitten by my own dog we have evidence of the clearest kind that they were bitten by a rabid animal. I myself saw the dog, and shot him, and the evidence was to me perfectly conclusive, or I would not have destroyed the animal

The 7 Cases – V to XI inclusive we may group together, and the remarks which follow apply to all the jackal bites recorded.

In Bengal jackals are very numerous and in the district of Rajshaye especially round the Station of Rampore Bauleah where I was placed they were a constant source of annoyance from their raids upon the poultry. In and around the station are many considerable belts of jungle and patches of uncultivated ground overgrown with long grass and reeds which afford "cover" for these and even larger animals

such as Leopards and tigers. The jackal* (Canis aureas) is about the size of a fox and indeed very like one; it is gregarious and nocturnal in its habits, and seldome roams about alone. It is naturally a very timid animal, and is rarely seen during the day, except in the early morning or at sunset as it skulks to or from its lair, choosing every lowlying ditch, "nullah" or dry watercourse on its way, to hide itself from man whom it dreads and avoids. I think it may be safely stated that a healthy or normal jackal has never been known to attack a human being, except under circumstances of great provocation, as when he is driven to bay, and has no other means of escape. Sir J. Fayrer when writing of two men

*It is of interest to know that this animal can interbreed with the dog (Canis familiaris).

who were bitten by one mad jackal says- "Only a mad jackal would do this, as it is a very timid animal and never otherwise attacks men." This is the opinion of all competent observers who have lived in outstations in India. It is therefore almost a certainty that all the jackal bites were inflicted by these animals while in a rabid condition.

II Is it not probable that the virus did not enter the wounds at all?

In answer to this objection I have to remark that I am aware that, from the results of experiments, it was found that, even with artificial innoculations with the saliva of Rabid animals," Röll says that successful innoculations vary from 24 to 70 per cent, whilst from the bites of rabid dogs the proportion varies between 20 and 70 per cent. showing that the disease is comparatively less likely to follow from the

Is it not probable that the virus did not enter the wounds at all?

natural (bite) than from the artificial (injection) introduction of the virus"*
But we must not give too much weight to these statistics. If these injections of the virus had been performed with a knowledge of the nature of the virus as was done in Anthrax by Pasteur. probably not one would escape; and as to the numbers that escape in Europe, where we are thickly clad with woolen, or cotton garments, the astonishment should rather be that so many contract the disease at all. Let us however give these facts, as taught us by statistics, their due weight, even in these cases, and we find that, of the fifteen cases, most probably one half, would have developed into hydrophobia: or one

*(G. A. Banham in Quains Dictionary of Medicine)

fourth of them – say 4 – would inevitably contract the disease. It seems to me tolerably certain that the virus must have entered the wounds in 4 out of 15 cases; but I think the percentage is far too low for India. All these patients were bitten on uncovered parts – unprotected even by the thin rag of cotton cloth they usually wear round their loins. Even a very thin layer of cloth over the skin may wipe the teeth as they penetrate, or protect the wound from being smeared with the saliva of the animal. I have seen a little boy suffering from hydrophobia who had only received a slight scratch from the teeth of a rabid animal on the bare arm, twelve days before, and he was dead on the fifteenth day. On the other hand I have known a Eurasian or half-caste young girl dressed in European

costume to have been attacked, and severely bitten by a rabid animal through her dress and cotton stockings and no serious results followed. The circumstance of the part being covered or uncovered should materially affect our prognosis. In the former, if no preventive measures have been used, it would be death; in the latter eight out of ten would escape. The certainty and rapidity with which hydrophobia follows the bites of rabid animals in India is appaling; and I attribute this to the naked condition of the people, permitting the rabid animal to get a deliberate bite of the uncovered part. and also in some way due I think to the influences of a tropical climate, which are so conducive to the speedy development of vegetable and animal life. In almost every case recorded a few hours,

and in some

as many as 24 hours elapsed between the bite, and the beginning of treatment; thus allowing sufficient time for the virus to enter the wound, or even to circulate in the system. In no case was a ligature applied to prevent absorption into the circulation.

III

May not the success of these cases be accounted for by the fact that from statistics in Europe we learn that, when no preventive measures are used two thirds of persons bitten escape?

It may again be asked — May not the success of these cases be accounted for by the fact that from statistics in Europe we learn that, "when no preventive measures are adopted at least half, perhaps two thirds of persons bitten escape"?* The proportion of those bitten by rabid animals who escape hydrophobia when no preventive measures are used in this Country, is no guide whatever to the number who escape in India. I have already said how seriously the matter of clothing or no clothing affects the issues.

(*W. R. Gowers; Quain's Dictionary of Medicine p 664.)

but will give one authentic instance which places this question of percentage, escapes in a better light. Surgeon J. Balfour for many years in India Referring to a native who had been sent him for treatment says - "The injuries (from mad jackal bite) were on the calf of one leg and deep but did not bleed much. I put the man under Chloroform, carefully excised the bitten part &c... The man was sent home with instructions as to future treatment. Of the 17 or 18 men who were bitten all died within three months, and this man recovered*" I quote this to show the proportion who escape in India! I am however not prepared to accept this experience either, as a true indication of the mortality to be met with; but it is much nearer the truth than to say

*(Lancet 2/77 p 618)

that, "one half or two thirds escape." I found from my brief experience that the mortality was very high probably two in three of those who were bitten contracted the disease even the one third who escaped owed their immunity to the habit - an instinctive habit - among men of washing with water any bite or injury of that kind. When observers speak of "no preventive measures being adopted" they mean Caustics, acids excisions &c forgetting that the poison may probably be washed out even by water, which is the instinctive resource to which any man would betake himself. In India however this is more marked as a habit, than in this Country; and I believe that the lives of many are saved by using this simple precaution.

The success of the Cases then I think cannot be attributed to the percentage

said to escape even when no preventive measures are used; for this percentage in India is very low.) I am therefore more disposed to believe that the permanganate of potash has in some way rendered the virus innocuous.

IV

What is the nature of the hydrophobic virus?

This leads me to enquire what is the nature of the hydrophobic virus?

In the absence of actual experiments on living animals, or microscopic evidence I am unable to answer this question definitely; but nevertheless, I think a great deal may be learned from the characteristic features of the virus, as seen from its behaviour in the system after inoculation.

If we consider the probable nature of this virus in the light of recent great and thrilling discoveries by M. Pasteur of Paris, we feel inclined to refer the cause of this mysterious disease to

to some lowly organised living germ with a life history, perhaps, not dissimilar to (Bacillus Anthracis). Although these two diseases – Anthrax and Hydrophobia – are by no means asserted to be alike either in their symptoms or pathology, yet there are certain general features, in which they do resemble one another. These points of resemblance may be tabulated as follows

	Anthrax	Hydrophobia
1	A disease of Herbivora communicable to man and animals.	1 A disease of Carnivora communicable to man and animals.
2	Having a varying period of incubation from 4 to 9 days*	2 Having a varying period of incubation from 8 to 90 days.
3	Communicated by innoculation	3 Communicated by innoculation
4	Virus remains at seat of innoculation for some days before affecting the system generally, and causing death.	4 Virus remains at seat of innoculation for some days, before affecting the system generally, and causing death
5	May be prevented by excision or destruction of point of innoculation	5 May be prevented by excision or destruction of seat of innoculation.

*. (Ch. Chamberland – Vaccination Charbonneuse p 53.)

I do not attach much weight to this somewhat artificial table of resemblance and yet it is suggestive; for if the one disease - Anthrax - is due to a minute organism - the Bacillus or Bacteria - as we know it is, may not the other also be due to a similar organism? The varying periods of incubation in rabies strongly support this view. I am persuaded that in India the periods of incubation is shorter than in this Country, as I have already stated, due to tropical influences: and this again supports the view that the virus is a living organism, dependent upon temperature or heat, moisture, and pabulum for its development. If we suppose the disease to be due to some living, Cowly organised being requiring suitable pabulum or media in which to develope itself, it seems but natural to expect that the process of development

must vary according to the part of the tissues in which it happens to be imbedded; for it is not at all likely that all the tissues afford equal facilities for the development of these organisms. Thus Bacillus anthracis is said to require for its growth the presence of nitrogenised pabulum - preferably albumen and a supply of oxygen"* If then we suppose that the germ of rabies requires similar conditions, these conditions are not found equally in the skin, cellular tissue, muscles, and blood. We can understand how a chemical substance like snake poison may be diffused with great rapidity in the blood even when not injected directly into the veins; and being carried by it to the nerve centres, produces its physiological action. But not so the living organisms. They may be supposed to injure the system in two ways (1) by their rapid increase at the expense of some of the important constituents

(* W. S Greenfield in Quains Dictionary of Medicine p 1304)
(A Wall on Indian Snake Poisons. p 125)

of the blood or tissues; or (2) by their mechanical presence as foreign bodies, acting as sources of irritation deranging or obstructing the functions of the animal economy. In order to be able to do this they must <u>increase</u> and find access to the circulation, and be carried to vital Centres; or, they may so alter the the Composition of the blood, as in Anthrax,[B] and unfit it to carry on its function of nourishing and renewing the vital Centres.

Now it seems to me that these curiously varied periods of incubation recorded by all observers in every Country - and which have ever been a most puzzling feature of Rabies - are but the expressions of the time, varying under different Circumstances, required for the development of these germs, and their transit to vital centres. I am aware that I am here stating nothing new

(B. Ch. Chamberland - Vaccination Charbonneuse) P. 71

original, Nor do I put it forward as such; but merely to draw attention to it as a ~~fact~~ theory which I think is corroborated by experience. Thus we know that even if no ligature has been placed on a bitten limb, excision of the part and thorough cauterization hours afterwards completely destroys the virus. If on the other hand we were dealing with a chemical agent such as snake poison which becomes absorbed into the system in a few minutes neither excision of the point of innoculation, nor any other local measures used, after an interval of thirty minutes, would be of any avail to prevent its fatal effects.

On the presumption therefore that we are dealing with living organisms instead of a chemical substance we may ask—

V How does the permanganate of potash render ~~the~~ the virus innocuous?

V

How does the permanganate of potash render the virus innocuous?

The permanganate of potash ($K_2Mn_2O_8$) is a well known and useful disinfectant owing to its oxidising powers. It is a very unstable compound in presence of organic matter, to which it readily yields some of its oxygen. It is doubtless in this way it acts on the virus of rabies; and when we remember that it was by means of the oxygen of the air that M. Pasteur attenuated the virus of Anthrax, we can well believe that, an agent like permanganate of potash, yielding large quantities of its oxygen to organic substances, will not only modify the virus, but utterly change the character of the organisms in the wound, destroying their activity and virulence. Recent researches[c] have shown that the permanganate of potash is one of several chemical compounds

[c] There is besides potassium permanganate, a large class of substances, which also have the power of rendering cobra poison inert. It is the class of metallic salts capable of precipitating albumen" Mall - Indian snake poisons

which destroy or render inert Cobra poison. The action of the permanganate on snake poison is that of an oxidising agent. It may therefore be urged by some that, if a Chemical substance like snake-poison is rendered innocuous or inert by the oxidising power of the permanganate of potash, it goes to prove that, if it exercises any destroying power on the virus of rabies that virus must also be considered as a Chemical substance and not a living organism. I admit there is some force in this objection; but we must not forget that in the organised as well as in the unorganised virus we have it built up of chemical elements, and they are both capable of undergoing chemical changes in the presence of other elements, for which they have an affinity. Thus if we knew the exact chemical formula which represents snake-poison we could represent, by a definite chemical equation, the changes

which would take place in its elements when brought in contact with the permanganate of Potash. In like manner we could represent the change that would take place in a living germ acted on by the same agent; but the results of that change would be widely different in each case. In the chemical substance we would have a rearrangement of its chemical molicules, so as to render the whole compound harmless to the animal economy as long as it remained so; but its virulence could again be restored by treatment with opposite chemical reagents. The organised living germ or virus on the other hand would undoubtedly have its chemical molecules rearranged also; but they could never be brought back into their original condition by any chemical reagents — in the one there is no loss that cannot be regained; in the other, there is the loss of something which can never

be restored. In the case of the organised virus it is made inert by a change in its chemical composition that unfits it for carrying on vital processes by which alone it can increase or develope, and so become injurious to the animal in whose tissues it is imbedded. I therefore consider that the action of the permanganate of potash on the virus of rabies is that of an opidising agent, destroying the germs without injuring the tissues; and that, if it does so, it possesses many and great advantages over the barbarous methods, often impracticable and ineffectual - which have hitherto constituted the sole armory of the surgeon when combating this, as yet unseen and unknown, but terrible, adversary.

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