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THE PRESENT STATUS OF OUR KNOWLEDGE OF THE RELATION OF MOUTH INFECTION TO SYSTEMIC DISEASE.*

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Mr. Chairman, and Members of the St. Louis Dental Society.

Without any introduction whatever of this particular subject, I shall ask you to consider with me one thing: That the acquisition of a new truth is identical with the acquisition of a new sense, for with it you can conceive, perceive and recognize things that you could not recognize before you had that new truth, and with that new truth you can perceive things that people without that truth cannot perceive. Have you got it? The acquisition of a new truth is identical with the acquisition of a new sense.

Let me give you an illustration. You take your little child out into the woods with you in the summertime when everything is dry. And you take your little revolver or your gun along, and you take some matches and a sharp knife or two. You do not leave them where that child can get hold of them. The child knows what a match is, it can strike a match, but the child does not know the danger of a fire.

Another illustration: Some twenty-three years ago next month, I was in Grand Forks, North Dakota, and came down with typhoid fever. One day I found myself lying on a cot in a hospital there with a physician on each side of the cot who were arguing, and almost coming to blows in discussing the question as to whether or not there was any truth in the germ theory of disease. Only twenty-three years ago; and the man who did not believe in the germ theory of disease was perfectly consistent in that belief, for

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his method of sterilizing the temperature thermometer when he took it from my mouth was to wipe it on the sheet of my bed. I need not tell you that I contracted such things as erysipelas, as did nearly all of his patients, because we all used the same temperature thermometer. That man did not have that new sense, which I am going to call the "infection sense."

When I started to practise dentistry, twenty-three years ago last June, I was just about as ignorant, and as incompetent to practise dentistry, as that man who did not believe in the germ theory of disease was to practise his profession, notwithstanding the fact that I had graduated at one of our best universities. I am proud to say the University of Michigan, than which there was no better school in the world. Nevertheless, I was utterly incompetent to practise dentistry, and when I think of the knowledge that I had at the time when I started practising and realize the conceit and the confidence that I had, I am appalled today that I should have undertaken the things that I did undertake. And when I see some of the operations that I made fifteen, eighteen and twenty years ago, and see the results on the patients, and when I take some of those same teeth that I filled the roots of fifteen years ago and refilled their roots ten years ago and others two years ago, and have later extracted and examined my work, I am believing that I am just about as ill-prepared to practise dentistry today as I was twenty-three years ago. I have not yet got that new sense that is going to be necessary before I will be competent to practise dentistry, and I am going to show you some of the things that I have been finding out about some of my own imperfections.

I am proud to say that American dentistry has perfected the artistic side of its professional work to a very high degree, and I am here to command every good operation and every good effort that our professional men are making. Gentlemen, I am not here to condemn you and your work, but I am here to condemn my own work and my own practice, and that involves yourself if you have been following the same.

Now, as we undertake to get a little vision of this "infection sense," I am going to ask you to consider with me first some of the things that seem to be sufficiently well established so that we shall not need to spend much time discussing them, namely, the relation of infections of the body to focal infections—not necessarily

of the mouth, but focal infections—and then we will take up some of the newer contributions to this science, and lastly, if we have time, some of the problems that we are undertaking to work out at this particular time. If after that, there is time to show the motion pictures of these various developments, I will be glad to do so.

We will have the slides as soon as the operator is ready, and he will show you first the Research Institute of the National Dental Association. I will take just a moment to tell you that while I am here with you one of the big corporations with considerable money, in the East, is holding a meeting of its officers today to consider our application for financial assistance. I want you all to be in a spirit of prayer while they are having that meeting. I do not know whether they will consider us favorably or not. I do know this, that if they ever had an appeal that was backed up by stronger endorsements, it must have been a strong one indeed, for we have something like fifty endorsements from the very strongest men that can be found in the United States in any profession, leaders of the medical profession, the great surgeons, philanthropists, leaders in the dental profession, and I have strong confidence that they will hear that appeal.

I want to tell you, too, that at the present time we are working under an arrangement of a budget of $20,000.00, and that we shall need at least $30,000.00 this year. The budget this year is furnishing us thirty workers, technicians, etc. The work is being carried on in different cities besides Cleveland, where a staff of nine is working, and I believe that you will be proud of the work that is done at that institution as well as by the directors of research. We are making the money spread around as much as we can.

This slide will show you the exterior of the building, and the second will show you one of the interiors. We have two splendidly equipped operating rooms. Of the $6,000.00 worth of equipment in that building, $4,000.00 worth has been donated gratuitously by individuals and manufacturers, and every contribution has been with the understanding that it carried with it no leverage nor opportunity of advertising.

That is the Research Institute of the National Dental Association. (Applause.) It is a building with thirty rooms and costing $50,000.00, of which $30,000.00 has been contributed and over

$20,000.00 paid in. (Applause.) The dental profession has contributed in cash and pledges to this time a little over $100,000.00 for the building and for the researches. The payments amount to a little over $50,000.00 of that $100,000.00.

This is one of the operating rooms, and it is not different from any of the others, except that as you see it, it is not perfectly equipped; but we have great reason to be proud of the equipment, it is as good as can be bought.

I wish you first to observe with me a few cases that seem to be typical of localizations from oral infections. This is an obscure case of dental infection of the lower incisors, of twenty years' standing. The patient had a boil on his chin, and a physician treated the boil. Some years afterwards a brother of the patient, a dentist, discovered that one of the incisors was discoloring and he took out the putrescent pulp and put in a root filling, which was imperfect. He did not observe that the other central was dead. This patient then carried a dead pulp for twenty years. The focal infection around this area seems to have been the cause of a lesion in that man's body affecting almost entirely the digestive system, particularly the liver. The man had not worked for four years, and for two years had been completely an invalid. With no other treatment than the removal of the apices of these two roots, the man so completely recovered that he was back in twelve weeks carrying on his business. He has gained so rapidly that he is in splendid health at this time. The significant thing is that the culture taken from this canal that had been closed except as the one end was in the tissues of the patient developed an infection in animals which selected out the liver consecutively, and the next slide will show us a typical liver infection. It is not unlike large numbers of miliary abscesses that we find, but note particularly, for we wish to revert to it, that the infective process has formed around a blood vessel. It is an embolic clot that was infected, and the infective process is felt, then, all through the blood stream.

Another type of case, a woman who has suffered for some twenty years with disturbance of her throat affecting her vocal cords, so that she could not speak naturally and most of the time not louder than a whisper. She can now talk nearly as loudly as I can, and I have a pretty good voice. She has been entirely relieved of the secondary disturbance by the removal of the infected

teeth. Her husband tells us that when he was courting her, twenty-two years ago, he could not kiss her on the mouth, because the teeth were so sore—it was no fault of his, that he did not. You notice that this area does not show great rarification, and yet cultures taken from that area, inoculated into animals, produced typical lesions; and this case is simply illustrative of a large group. I have five complete histories where the voice was lost and was restored by the removal of a dental infection.

This is a different type of case. Here is a woman who came to us when we started the work in the Institute a year ago. We did not get a picture of her at that time. You notice the marked deformity of the hands; you notice here that she is standing on her feet. She had not been on her feet for eighteen months either with crutches or the assistance of a nurse. For three years prior to that time she had been limping on crutches. She can now walk alone, and twelve weeks after we had removed the dental infections she was able to walk up a flight of seven stairs with her crutches. She can now raise her hands to her head, and is improving rapidly.

The next slide shows some of the deformities, the elbow being very rigidly fixed.

The next shows the dental condition. You will note, particularly, the areas of infection, and she had had a lot of dental work done. I shall not stop at this time to discuss the methods of culturing.

A different type, iritis. You notice that one of this man's eyes is blurred and the other is normal. We see many of these cases. The last rabbit I examined before leaving, yesterday afternoon, had developed an iritis similar to this that is shown here.

Another type, extreme arthritis. This woman has been getting steadily worse for eight years. She had a family of four children, all of whom had been placed in institutions. She is raising her hands there as far as she can and rotating her head as far as she can. Her husband had to carry her and she would have starved if she had not been fed. Conditions were so bad, and had been bad, for so long, that she tells me her husband had said to her that if he stayed with her she must either die or get better. Remember, her children had been taken away from her, and she had the normal instincts of a mother to love her children and want to hold them. In that desperation she was brought to the institution. That

woman today is cooking the meals for her four children in her own home where they have been brought to her. (Applause.) And I think she is very happy, and I think her husband is very happy, for within a few weeks she expects to have a fifth little child to grace that home. Now when I tell you that that one case has been compensation to me for all the time that I have ever given to this work, you will understand it, for that woman's heart goes out to me with an appreciation that our ordinary cases cannot at all give us.

Here is a condition of the spinal column. You will notice how densely filled in the vertebral column is, also the distortion of her hands. In this, you see the dental lesions. Now to me it is a tragic thing that so many of these cases are having as good work revealed as the average dentist was doing ten years ago, or perhaps today. This woman went to a better than ordinary dentist. Here we have the lower bicuspid, which was the tender tooth in that mouth and had a fistula; and I want you to know this, that the lesions which we should be most afraid of with reference to systemic infection are apparently those that produce least local trouble. We find in ten to one of these cases of arthritis that seem to be related to dental infection that there is no fistula present.

Here is a poor woman. You see the gold crown and the fairly earnest effort to fill the root, and in that mouth there were five apical areas of infection, as you see, and only one with a fistula, this bicuspid. Yet that woman had no local trouble. She had been in the hands of splendid physicians in a hospital. They had called in a very excellent dentist to examine the mouth and without radiographs her mouth was announced to be in perfect condition and no danger that her trouble was coming from dental lesions. The dentist who did that, you see, did not quite have the "infection sense."

Here is another very extreme case. This man has not walked for eight years. He has been getting so rapidly worse, or, rather, so seriously deformed that it was an impossible thing for him to attempt to wait on himself. He was just like a statue as he would lie in his bed, and suffered a great deal of pain, unlike a great many of these cases. That man's pain was entirely relieved inside of a month after the removal of the dental infections. His general physical condition has improved so much that he sits up

and feeds himself, although he cannot walk yet. He has been entirely free from pain for nine months and is so entirely comfortable that he says, "If I don't get any better, I feel like a well man now." Imagine the gratitude of a man who cannot yet walk at all, yet feels satisfied, feels that it is good enough to be free from the pain he has suffered! We do not know what a terrible life it is. Some of these patients whom I see have the prospect of twenty-five, perhaps thirty-five years to lie dying slowly with arthritis. He was as helpless in his bed as in a casket, and, as we all know, many of these patients live a great many years, terrible as their condition is.

Here are the dental conditions found in that man's mouth. He, too, had been in a hospital and they looked at his mouth there and said that so far as they could see there was not sufficient cause to be found in it. Yet from all these areas of infection we got typical localizations, which I will discuss later.

Certain tissues of the body seem to be elected by the organisms, and here we have a typical stomach ulcer. And the thing I want to impress now is the possibility, as emphasized by Dr. Mayo, that the increase of cancer of the stomach may be due in part to the increase of peptic ulcer, for so many cancers of the stomach are superimposed on ulcer of the stomach, so that the dental infection may indirectly, by the production of an ulcer, produce cancer of the stomach. In other words, a dental infection may be produced which seeks out the stomach for secondary infection and incidentally gives rise to the ulcer, which becomes the site of a cancer.

The mechanism of these infections is of two kinds; chiefly by the blood stream, as in the stomach ulcer where the infective process takes place down in the mucosa and breaks through into the stomach. You can see in animals this process very clearly. There are deepseated infections on the peritoneal side of the stomach, and later you will find it has gone through into the stomach.

The next slide will show us a heart infection. You will note the mass of streptococci and micrococci in the blood stream. Here a heart valve has been affected, and we will discuss that later; but the thing that I want you to have in mind is the mechanism of these things, which is so largely through the agency of the blood stream.

Some of the difficulties of root filling, as suggested by our

splendid worker, Dr. Callahan. You will understand the difficulty of filling the numerous foramina, since none of them is in direct line, with free access from the canal.

A still more difficult canal with an island in it.

Another island. This is one of our Dr. Callahan's slides.

Here are some of the root fillings that he has taken out by dissolving the teeth away from them, simply to show you how difficult it is for us to get into these canals with our ordinary technic.

Here we see a canal filled out through the side, a secondary foramen really filled by a dentist who has tried faithfully and hard, and that could not be accomplished by many of our systems of technic.

This is a cross section of dentin, the tubules of dentin, and they are infected with bacteria. Now you will readily understand the difficulty of sterilizing these organisms clear back in these fine canals; and I am not going to say what you can or cannot do, I am simply going to tell you what I cannot do. I cannot put medicament in any canal that I have tried it in, and I have tried to do it in some fifty, I think. In the mouth I have used everything from sulphuric acid to as strong formalin as I dared to put in, even full-strength formalin where I expected to extract, if necessary, I have not in one, single case where the pulp chamber was infected and not suspected of infection beyond the apex, (for there was no life in the tissue by our tests) produced a sufficiently sterile condition so that the dressing of cotton on which I placed that medicament in the canal of the tooth, leaving it there for forty-eight hours, would not grow organisms in the apical fourth of that dressing. Try it for yourself. It is a thing that any one of you can do; all you need is the right kind of technic and the right kind of culture media. I say again, that I have not in one, single case with any medicament that I could use failed to get a growth from the apical fourth of the dressing when I left a dressing saturated with that medicine in the canal for forty-eight hours; and if I left it for seventy-two hours to four days I could then get it up halfway through the dressing. Why, the organisms beyond the teeth themselves, in the tissues, come back into the canal and infect my dressing and my treatments in the canal do not affect the organisms beyond and my medicament that I put into that root canal does not stay in the root canal. Because of the very laws of physical

osmosis and physical dispersion, that medicament spreads itself out through the blood plasma, and this blood plasma comes in to take its place.

I wish that I had time to discuss with you some of the newly observed physical laws that can be applied to our work. This is an old one. Every medicament that is in solution, every chemical that is in solution behaves itself precisely as if it were in a gas form and the same molecular pressure as if it were a gas and goes out the solution was not there. That is, if you have two medicaments side by side, one saturated with chlorid, that chlorid behaves with through the other liquid and all the other tissues until it reaches an equilibrium.

Another thing that I wished to bring out is this: There has been some splendid work done at the Research Institute and in other places, most of it not yet published, on our inability to sterilize dentin even when we take it out. Take a number of teeth and invest them in plaster outside of the mouth and put in forty per cent formalin, and you cannot get a hundred per cent sterilization in forty-eight hours, leaving it in in full strength; the organisms will come right back in from that dentin, notwithstanding all you may do. Now what does that mean? There is a whole lot, gentlemen, that we have taken for granted that we have not the slightest reason for taking for granted, and we might as well acknowledge that. We are in the same position as that man was who sat by my cot and argued against the danger of me being infected or infecting any one else on the ground that there was no truth in the germ theory of disease. This is not literally the same problem, but it is also concerned with the interest of mankind, and we will see twenty years from now that we were in exactly the same position.

I want to discuss for a few minutes the splendid work that is being done, that is foundation work, really, on the localizations of organisms and those tropisms that organisms develop when living in certain tissues for certain other tissues. I am going to repeat for emphasis, and, for fear somebody has not got it, this point: The phase that I want to discuss now is the ability of an organism to grow in a focal infection and develop a tropism, or selective affinity, for certain tissues of the body; and that the organism growing, for instance, in a joint develops an affinity for joints, and the organism

growing in the appendix has an affinity for the appendix, and so on through many strains.

Now Dr. Rosenow has made this monumental contribution, and I simply repeat it for review. When he has taken organisms from focal infections in cases of mumps, myositis, endocarditis, gastric ulcer, etc., he has found that the strain taken, inoculated in animals, developed lesions in the animals which corresponded with the lesion from which he took the organism in a large per cent of cases. For example, when he took organisms from the appendix and inoculated in rabbits, sixty-eight per cent of them showed the organisms selecting the appendix. When he took morphologically the same organism—that is, a streptococcus—from other sources and inoculated it into rabbits, he found only five per cent selecting the appendix. It was the same way with ulcer of the stomach; sixty per cent selected the stomach, where only twenty-nine per cent selected the stomach and duodenum when he took them from other sources. In cholecystitis, he found eighty per cent selected the gall-bladder, where only eleven per cent from miscellaneous sources did. In rheumatic fever, sixty-six per cent selected points. Then we find forty-six endocardial, twenty-seven pericardial and forty-eight myocardial; where the ratios were eight, fourteen and two when selected from miscellaneous sources. A definite location, you see, on the part of the organism which is more pronounced when you come to erythema nodosum, for he found that ninety per cent selected the skin where only two per cent from miscellaneous strains selected the skin. In herpes zoster, we have seventy per cent. In mumps seventy-three selected the parotid gland, and not a single strain selected the parotid gland when he took them from miscellaneous sources. Yet under the microscope, you could not have told those organisms apart.

As monumental as that piece of work was, Dr. Rosenow has gone one better and has this last year made a contribution in which he has demonstrated the ability of these various strains of the streptococcus group to select nerve tissues, accounting directly for a great many of the reactions of the nervous system which we have not understood, such as neuralgia, neuritis, etc. When he took the organisms from multiple sclerosis and inoculated into animals, he found that in fifty-eight per cent of the animals they selected the spinal cord. When he took from miscellaneous sources, only four

per cent selected the spinal cord. Again, when he took organisms from epidemic anterior poliomyelitis, he found seventy-eight per cent selected the spinal cord; from transverse myelitis, sixty-seven per cent selected the spinal cord. When he took them from a typical intercostal neuralgia, he found that seventy-nine per cent selected the nerve trunks. When he took them from multiple neuritis, forty-six per cent selected nerve trunks. From neuritis and myositis, forty-six per cent selected nerve trunks, and fifty per cent the teeth. From myalgia, ninety-three per cent selected muscles; and twenty-six per cent, the heart.

Here the dorsal roots of the spinal column were selected in eighty-three per cent, when one strain was used, and in not a single one of the other strains. That one strain was neuralgia, and we have never before had any idea of what neuralgia is. We have talked about symptoms of diseases; we are going to find, I believe, from this series of researches carried on in different places, some important, hitherto-unknown relations in disease, and sources of disease, particularly with regard to neuralgia.

I want also to call attention to this fact. You have all seen, as I have, that patients will sometimes present with involvement of the pulp of a healthy tooth, and we have not found what it was and, apparently, it goes away. It is a streptococcal infection, for we have now seen a case history where just preceding it by two weeks the patient had an epidemic streptococcus sore throat, in all probability an organism that selected out the pulp of those teeth.

Here we have a typical paralysis produced by Dr. E. C. Rosenow in his experimental work with poliomyelitis, or infantile paralysis, and it is a wonderful tribute to Dr. Rosenow that he has gone to the refuse, as it were, and found the organism, for it had been declared by many of the leading bacteriologists that since this lesion could be produced by a filtrate that went through a Berkefeld filter, therefore it could not be a streptococcus but one of the filterable viruses. But Dr. Rosenow finds that streps. may grow so small that they will go through a Berkefeld filter and then develop in large size afterward, for he has a typical case produced with a streptococcus with a special electivity, and here are the lesions in the spinal cord showing definitely the method of its localization.

Here we have a large number of different sizes; and, remember, the original organism that produced this culture went through a

Berkefeld filter and was smaller than any you see on the field. Yet from that small organism there developed both the large one here and the small one here. Over here is one where probably the whole chain of these cocci is smaller than one in this large chain.

There has been another great contribution during the last year, in addition to this method of which I have been speaking. Dr. Rosenow has made this most important contribution on electivity of nerve tissues, and Dr. Hartzell in his work has demonstrated the fact that the biochemical reactions of the organisms are not related to their virulence or their electivities. Dr. Hartzell and Henrici, then, have developed the biochemical tests into the two groups of hemolyzing and nonhemolyzing. Here are the hemolyzing strains, and the so-called nonhemolyzing, salicin fermenting or nonfermenting organisms, the fecalis, nitis and salivarius. Now the significant thing is that when they have gone through a large number of organisms, a large number of cases with a large variety of strains, they have found that these organisms select out the various tissues without any respect to the fact that they hemolyze or do not hemolyze, or whether they ferment salicin or do not ferment salicin.

Here, then, is a group of the reactions of the organisms. No. One of this group of organisms produces a reaction in the tissue, and the reaction in a tissue is Nature's method of repair. Now we may get an exudate form, or we may have the lymphocytes develop in the tissue, or we may have proliferative growth of tissue; but it mattered not whether it was pyogenes, Group One or Two, or whether it was mitis or salivarius or any of the strains, hemolytic or nonhemolytic, for we have about the same per cent producing these reactions in tissue. Therefore, you cannot by your sugar fermentation itself tell what virulence that organism will have in tissue; at least, that is the suggestion from their work.

We should take a half hour on this one slide, but we can take only about two minutes. This larger column of three charts to your left represents the hemolyzing group; that to your right, the nonhemolyzing. The first seven columns are myocarditis, endocarditis, arthritis, myositis, lymphoadenitis, splenitis, nephritis. You will notice just by looking at the height of these various columns, which show the percentage of animals reacting to each, that there is very little difference in the first seven. Here is one, though, that is very low in selecting; the first, lymph tissue. But, in general,

you readily see that the selectivity of the organisms for tissues had almost nothing to do with those biochemical tests. Again, they all show a very high column for infection, independent entirely of the biochemcial reaction in relation to virulence. We also see that the animal's death, or septicemia, was produced in proportion, in part, to the amount of hemolysis, for the hemolyzing strains have produced more dead animals—more virulence, in other words, than in the nonhemolyzing.

Again, when we compare the hemolyzing and the nonhemolyzing by condensing all three columns into one, you see relatively very little difference. That is the point you need to get into your mind, the fact that you cannot tell by growing your organisms on the blood-agar plate whether or not a certain organism will be likely to produce a myositis, an arthritis, or any other one condition.

Again, take these various selectivities for tissues and compare them to the reactions in regard to sugar fermentation. In the group at the top we have the streptococci fermenting both salicin and mannite; in the next, fermenting salicin, but not mannite; in the two next, neither. To those of you who are bacteriologists, this will be a very important and significant contribution. Drs. Hartzell and Henrici have found definite lesions in the brain where the organism used was taken from the brains of patients dying from chorea. We have known very little about chorea, or St. Vitus' dance, but it seems very probable that the rheumatic-fever group of organisms will produce a selectivity at a certain stage of development that will pick out certain brain tissues and will produce a particular lesion which we know as chorea.

One of the very important contributions they have made in that series of experiments has been to show that about half of the cases of heart valve infection were not embolic, but were deposited from the blood stream. Here we have the typical embolic infection in the base of a heart valve, showing that the lesion did develop from the blood stream. The next will show us a heart valve where the vegetation is attached to the tip and has no connection at all with the blood stream; in other words, this one has been affected because the organism was drifting in the blood and attached itself to the valve. So we get both kinds from either strain of organism, whether hemolyzing or nonhemolyzing.

We are very likely to believe that when an organism infects

the apex of the root and we have used any one of our various methods, such as ionization, for treatment, and get a filling in of bone around that tooth, such filling in of bone is a proof that we have restored that tooth to natural conditions. One of the rudest shocks I have had lately has been to find that just such a condition, of which I will show you the radiographs, was not in a normal condition although the bone had filled in around. This is taken from Dr. Black's splendid pathology, and you note how the bone has filled in. I use this simply as an illustration of how the bone may be caused to fill in.

Now let me say this, relative to ionization: We have been and are doing a great deal of experimental work with ionization, and we find that ionization seems to stimulate the tissue beneficially. We have, however, this to report—it may not mean anything, for Dr. Rhein has suggested that perhaps we have soaked the tissues over the gingival margin of the teeth from some other part of the body—that where we have used ionization, in all of its forms of application, we have never once failed to get a culture from that apical area by aspiration, whether we did the aspiration immediately after ionization, or an hour after, or a week after, or a month after ionization. And, again, we have found that it seems to make no difference whether we have used zinc or platinum or zinc chlorid or common salt. I wish that I had time to go into the discussion of that particular problem. As I have not, I will only say that we are doing splendid work in the Institute this year. We have one of the very best bacteriologists working with us. He is trained particularly in cell metabolism and the things that take place within cell membranes under various normal and abnormal conditions, and we expect to have something worth while to report later.

I want to give you this suggestion, relative to radiographs. The angle at which the ray reaches the film and the tooth determines entirely whether or not the length of the tooth is any guide as shown by the radiograph of the tooth itself. If we put our ray too nearly parallel, or at right angles to the plane of the tooth, we get an elongated tooth as shown in this case. If we put our angle too high, we get a shortened tooth as shown in this case. If we divide the plane of the film in half and make our ray strike a plane which is halfway between the plane of the tooth and the film, we will have a shadow of the tooth which will be just the length of

the tooth; and you can put a large film into the mouth perfectly flat and get just as good a picture of the upper front teeth, provided you get your angle right, as if you tipped it up into the angle of the mouth. It all depends on your bisecting that angle.

This is the instrument we use for aspiration, simply a four-ounce rubber tubing or glass tubing, and when we see a condition that calls for aspiration in a tooth, if we cannot get moisture away, we dry out the area, pinch on the tubing and leave a vacuum there for twenty-four hours, and nearly always find blood serum when we open it up.

I wish that I had time to discuss the problem of over-medication. I would use this as an illustration. I believe the time is, not coming, but is here, when it will be known as a very gross offense to the tissues of the mouth to use arsenic. Here is an illustration. We have put arsenic in this tooth and sealed it in with both amalgam and cement; yet enough arsenic in a few days has come through the periapical tissues and back through the gingiva to produce these large eschars on the tongue and buccal tissues. Here we find the periosteum is almost entirely filled in with a dense fibrous tissue. It is the type of tissue that has a low blood supply, and therefore Nature's own resistance cannot keep it from being infected with blood stream infection. We are probably overmedicating with the medicaments that we are putting inside canals.

I wish now to speak of some of the work that is being done by the Research Institute at Cleveland. This first case is a typical arthritis, the patient having multiple arthritis in the acute inflammatory stage, with rise of temperature about every week. Aspiration with a needle forced through into this area beyond the tooth gave us an apparently pure culture of streptococcus, which when inoculated into animals has produced successively in two animal passages and in seven rabbits arthritis. That was produced in all of the animals. There have been a few other tissues involved, particularly when we used large and over-doses.

The next slide is more interesting. Here we have a patient that I have been responsible for for eighteen or twenty years. Eighteen years ago that woman's hands were photographed and a radiograph made as you see it here. Here is a normal hand and here was her hand. I am sorry that I have not got a picture of her hand as it is today. The fingers are, however, so closed that she

now plays the piano with her knuckles instead of her fingertips. Her fingers are entirely closed into the palms of the hands. She has developed an arthritis so bad that ten years ago she began to use crutches and three years ago she could not get around on crutches without some one to help her. Ten years ago, I said to her, "I am afraid this might be caused by your teeth and I would like to make some radiographs." I found a bicuspid with a root filling only halfway to the root. I took that filling out, put in a first-class root filling, as I thought, and went around patting myself on the back because the woman began to improve. But one thing that seems to be conspicuous in these cases is that infection is a relative matter, due to the amount of organisms and the patient's resistance, the kind of organism. This woman, after a period of improvement, got worse until three years ago she was almost prostrated. Then we found a bicuspid on the other side of her mouth, with a putrescent canal. We thoroughly treated and filled that canal. She got a great deal better, enough better so that she gave up her crutches and goes all about the house, so much better that she said that she was even better than she had dared hope to be or had dared pray that the Lord would make her, for she had felt that if she could only leave her crutches alone she would be completely happy. She has now been for about a year in about the same condition.

Now ten years ago, I took out a filling and put in a better one; two years ago, I took out a putrescent pulp, treated as well as I could, and put in root filling. This fall, I said, "Now I want you to come to the Institute and let us study your condition; you are not getting better." She said that she would and did, so I extracted first the tooth that I filled ten years ago after desensitizing the tissues, using the actual cautery and burning the tissue to the bone all around the neck of the tooth, and extraction was a very difficult thing indeed. Cultures grown from the tooth, both from the scrapings of the bone and from the end of the tooth, gave a strain that attacked the joints of animals and three generations of animals have developed an infection in the knees. And in that case I had done just as good root filling as I knew how to do. Well, then, I got after the filling I had put in two years ago, and in that case found pretty good root filling. Then I took out the filling that I had put in two years ago, and that tooth was so

difficult to extract that I was afraid I would break it in extracting. There the radiograph shows a density of bone around the apex instead of a rarification, and without exception the animals inoculated, through three generations now, have shown an involvement of the knees, an arthritis.

Again, that patient's reaction has been so marked after each of those extractions that her temperature went up a degree in one case, a degree and a quarter in another, and, in fact, at one time she had an acute rheumatism. She could not find a comfortable place for her hand in the bed after the first extraction; and in the second case the reaction was so great that she had to awaken her husband to help her get her knee covered. Now what does that mean, if it means anything to you or not? I do not know how you are going to explain it, I want you to tell me; but the thing that seems probable to me is, since I was able to get a culture there, that although the filling seemed to go to the root yet a surface was left there in which the organisms could live and did live notwithstanding that the bone grew down right close to the roots.

Now let us see the radiographs. There is the tooth that I filled two years ago, two canals coming to one, as you see, pretty good root filling, and very little rarification, as you can see, about that apex. Here is the one that I put in ten years ago, and that is as far as I could get into the canal. Note how much more dense that bone has got around that tooth; for here is the radiograph that I made ten years ago, here is that imperfect root filling and here it is after I had done it more perfectly, and you note how much more dense that bone is around that tooth. Now I could easily use that as an argument, if I wanted to, that changing a root filling had improved the condition about that tooth. My hands are up, I am a "dead one" so far as answering that question is concerned. My only explanation is that organisms had been growing in that tissue notwithstanding the fact that I cannot by the radiograph recognize an area of absorption.

Now that woman has had this reaction after the removal of those two teeth. She has been so much better that her mother has said to her, "Why is it, daughter, that you do not lie down now every day for a rest?" The daughter told me of that and said, "For two years I have had to lie down because of a prostration, a

sort of heart burden, a load that I seemed to be carrying, and since that extraction I have not had to lie down one single day."

Here is another type of case. These are cases that we are running now in the Research Institute. Here is a woman who has a neuralgia of the back of her neck and has had it for years, with a heart condition. I do indeed wish that I had time to give you the case histories of these people and show you how there has been a sensitiveness on the part of the patient to the rheumatic group of infections all during the lifetime—they have all had growing pains when children, for example—and how many of us are getting our case histories complete? We never can know our case until we have a complete case history.

Now this patient has had this neuralgia in the back of her neck, and she came simply to have ordinary dental work done, and if we had been just mechanical dentists we would never have gone any further. But when we were going over her teeth, I said to her, "Now what about the possibility of your health, the state of your health, having something to do with this dental condition that we find here?" She said, "I have come here just to have this dental work done, and I go to my physician about my health; all I want here is to have my teeth put in good shape." "Yes," I said to her, "but perhaps the physician would like to know what we find, and I want to know for my own satisfaction. Now you don't look very well to me and I have known you for fifteen years and I want you to give me the history of your case." So she did, and we examined her and found four or five teeth with apical infections, and those gold crowns, which I am glad to say I did not put on—I have not put on a gold crown for eighteen years—were removed, and when we removed one of those teeth we made a culture and inoculated it into rabbits. Three rabbits, each inoculated with the same culture, but with a different quantity, developed the same lesions of the neck.

Here we have the first generation, the first rabbit infected. See how it is holding its head over sideways. This is the same rabbit, rabbit No. 105. Now in posting that animal, we found a lesion in the back of the neck right where you see the spot on that woman's neck. We took a culture from that muscle and inoculated another rabbit, and here is the other rabbit, with its head held down, as you see. We found several muscle lesions in that animal and took

organisms from that rabbit and inoculated another, and here it is. When I came away another passage, the fourth successive rabbit, had developed that same lesion so far as we could tell, and not one other animal this entire year and a half that we have been carrying on these researches has developed that particular lesion.

Now when we started this work this fall, our new bacteriologist said to me, "It has not been demonstrated to me at all that there is any such thing as selectivity for tissues and I think this is just a waste of time." I said, "It makes no difference; that is our problem for this year, and we are going right after that problem."

In this connection, let me tell you another thing. I took the second tooth from this patient and inoculated a rabbit from that second tooth, and it has developed the same lesions. Now the second animal passage has developed it again and with it, as I saw last night, an iritis. This woman has been troubled all these years, as far back as she can remember almost, with pain in her back in the lumbar region over the kidneys, and she has thought that it was due to kidney disturbance, but the probability is that it is simply a myositis. We give all these patients a complete physical examination, probably more complete than ninety per cent of the hospitals in the country give their patients; not only take complete case histories, but have a complete physical examination of every organ in the surface of the body.

Now as we come to the motion pictures, I want you to have in mind two or three things in particular; that is, certain groupings of the organisms. Here we have the streptococcus. For those who are not familiar with it, the name means, "a string of beads." So you will notice in the fields a little string of beads. Here is the staphylococcus, "a bunch of grapes"—growing in a bunch, you see. And here we have the streptothrix, and leptothrix and the spirochetas, such as the pallidum which produces syphilis, etc. I simply give you those general characteristics to help you to recognize the different ones in the pictures.

Now while they are getting ready for the motion pictures, I wish that I might study with you one thing—and there are so many things that I would like to take up—that is, the significance of reactions on the part of patients. The reactions of the patients are very significant, and one of the most important things for you to watch is this: When you have done anything to your patient, see

whether or not that particular operation produces some effect on the patient. The patient may not recognize it, so insist on taking the temperature, insist on the patient making a definite record of lassitude, a definite record of increase or exacerbation of certain symptoms they have been suffering with.

I will not tell you anything more important today than this: That when Dr. D. D. Smith eighteen years ago discovered from a clinical standpoint that it was better to clean teeth every month or every six months, he discovered by a clinical means one of the most important discoveries of modern bacteriology and pathology and physiology, namely, that the way to keep well is by constantly stimulating our resistance up to fight the organisms that are attacking our bodies. Some men in their derision have been tempted to call it the "monthly manicure graft," but it is in fact the best and most logical thing you can do for your patient. By giving a frequent, a monthly or bimonthly or weekly, if need be, treatment for pyorrhea you do this thing; you stimulate that body to fight the organism that is attacking it. Have you not noticed this? I doubt if there is a man in the room that has not if he has kept his eyes open at all—that you have seen a response on the part of your patient that was entirely out of proportion to any deposit that you may have removed; and you have wondered when that patient came back a week or a month later and things were so much better how it was and thought, "Well, I am getting credit for an awful lot here, the patient thinks I did a lot for her, and as a matter of fact there was scarcely any deposit on her teeth."

If you will try this little experiment with those cases of taking a bur of some kind—I do not mean a long bur, but it may be simply a little reamer of a very small size, like a large spiral broach—and put it in a handpiece and while it is revolving just go around the necks of the teeth and stir up the contents of the pyorrheal pockets and leave them in there, not as a means of treatment but as an experiment, just stir things up, make things bleed, you produce a reaction that in many cases will put that patient to bed the next day even if you do not remove any tartar at all. Why, Nature's mechanism is to put a whole host of white blood cells into the tissues ready to receive the organisms as they come in. And another thing, there are antibodies, there are chemicals in the tissues ready to neutralize the bacteriological products that are soaking into these tissues and

just as soon as you produce a hemorrhage you let those wash out of the tissues and your toxins get into your patients.

The thing that ought to be done is to inoculate the patient with his own germ. If vaccines are ever of any account, they are best when they are made from the very organism and the very strain in the lesion. In other words, a live organism getting into the system from a focal infection will do infinitely more than can be done by taking it out and growing it in a test tube and making a vaccine to inject into your patient, for you modify it immediately you grow it on artificial media. I want you to get the "infection sense," that new sense that will make you just as different from the ordinary dentist as the physician who now understands bacteriology is different from the one back there who did not believe in the germ theory.

I am sorry for your sake that the room is not dark, and I fear the film will be a disappointment to you, since the organisms are so small and we need the best circumstances for showing them.

I want to take this opportunity to discuss another matter. The bacteria that you are going to study as you get interested in infections are so nearly like you that they are really your cousins, if they are not your half-brothers. Every living thing, whether it is a bacterium or whether it is a dog or whether it is a man, lives by the same process. Every cell, no matter what its source, lives by the same process; it must do three things, it must be in the presence of food, it must assimilate food, and it must eliminate. Now we have supposed that our organisms had some wonderful function or property that was entirely different from the things we recognize in animal and vegetable life. It is not so. They respond with mechanisms almost identical with the mechanisms of animal life, and I am going to show you first what you looked like when you were a little one-celled animal. We will show both the ovum and the sperm that fertilizes it, and you could not tell either one from the bacteria that I will show later on the field; they are in every sense unicellular organisms just as the bacteria.

Now when you get an opportunity I wish you would make this experiment. Catch a frog, just pull a little of the mucous membrane out of his throat, after killing him, and tease some of the surface cells off and put them under a microscope, and you will find that these cells will swim all over the field just like bacteria. Swim? Why, they have cilia on them, and those cilia react mechanically and

that mechanical reaction of the cilia is the thing that makes the organism swim; and the bacteria that we see swimming about are attracted by certain chemicals which attract the cilia or the flagella. They do not have a mentality, a consciousness that makes them, seemingly, select out those tissues, and the thing that you should try for is to get this mechanistic conception of life. Think of them responding to chemicals just as the chemicals in your test tubes respond, and they all of them respond to irritation just as a frog responds to irritation, etc.

We will first study, for comparison, simply to give us an idea of what bacteria are like, the ovum and sperm of certain of the small sea forms, murex, starfish and sea-urchin. This is a starfish about as large as a person's hand. This is the sea-urchin. In these sea forms about four-fifths of the body is given over to the formation and production of reproductive elements, either eggs or sperm. This, then, is the egg of the sea-urchin, and you will note on magnifying it that it is filled with a granular mass, a little fine network that looks almost precisely like bacteria, and when we put the sperm in the field they are attracted by chemical action to the ovum, and only one is able to get into the ovum because immediately one enters this fertilizing membrane forms about the egg and shuts off all others. This is the fertilizing membrane, and all through the field are the living sperm.

Now we have this first division—for each one of us was first a one-celled organism—and then there comes a two-celled. Here is the two-celled, and we did precisely as this egg is doing, dividing now into four-cell. You note the difference in the shape and the nuclear masses forming, and as those various divisions take place we get finally a membrane surrounding a large number of cells, but always in regular form. Here we have an eight-cell in side view, and here it is in full view. They are as regular as a mechanic could make them, and yet there will be perhape a half-million in one of the small animals. We will also find sixteen, twenty-four, thirty-two, always multiples of two, and finally the swimming forms appear. If you remember back to your embryology, you will remember the three layers, epiblast, mesoblast, and endoblast.

Here is the sperm inverted into the egg just as you would press one side of a rubber ball if you punctured it, and it swims all about in just a few hours after fertilization. I am sorry that the room

is not dark. You will not see very much of this, but we cannot help it.

This is the starfish egg and it fertilizes a little differently. If we were studying this from the embryological standpoint we would discuss the getting away of the polar bodies which we see here carrying away the extra chromosomes to make room for the male chromosomes that come in at the time of fertilization. Here we have the sperm, and you could not tell them from the bacteria that I will show in a moment. Here is the egg; watch it being fertilized and you will see a sperm entering at the top. Here one polar body, in this case, comes off before fertilization and one after; one is outside, and one inside the fertilization membrane; and now this fertilization membrane is keeping out all other sperm so that only the first one enters, and the sperm are swimming around the field precisely as the bacteria will. Here is the polar body. Now watch the fissure go through the cell, dividing it into two, with your extra chromosomes carried in this polar body.

Various two-celled stages. Here is your nucleus dividing. Now for your four-celled stage. Now some of these divide so completely that they will fall apart, and if they should fall apart they would make two organisms. That is what happens when twins develop in the human life and are similar—they are due to a split ovum—when they are dissimilar, they are the fertilization of two ova. Now if that egg should divide, two entities would develop so like that you could not tell one from the other, since each has carried the same determinals.

Here we have various developmental stages for chromosomes. The chromosomes do not show, but the nuclear body carries the chromosomes.

Again, the four-cell stage in the mitotic division. The first fissure will be precisely as in bacteria, as you see it here. Here we have our eight-cell stage and the living sperm swimming all about the field for hours after, but only one enters because of the fertilizing membrane. We see the cells increasing in number, and pretty soon it tries to swim. Now this particular type is the starfish, and you see the skeletal forms quite distinctly, forming. Here they are swimming about.

This is murex that we are now looking at. You note the large droplets carrying the food and here is the perfected murex, the

three-segment stage. You will notice how perfectly like the cells of tissue taken from the throat they are. I will show you in just a few moments the other cells, and you can hardly tell the difference in the way they behave; in fact, they are precisely identical from a biologic standpoint.

Here are the cilia highly magnified, precisely like the cilia in your throat or mine, and this developed form is almost like the one-unit cells taken from various parts of the air passages of our bodies. Now if we study the ciliary mechanism of such an organism as the frog, we will get the following condition, though this was taken from the clam, I think. There is what I told you of; there are the cilia making a slow swim around the field almost precisely as if it were a bacterium.

Here we have the more highly organized endameba, and you see this vacuum open and close; you see the mass of undigested food. This is growing in water, a good deal like the ameba of the mouth. You see the vacuum open and close just like a shot, and that is the beginning of the operation of a process something like the stomach. These organisms all have digestive fluids just as you and I have.

Here we see the organisms taken from rapid decay of the teeth, that you get in pure culture growing in the decay around the necks of these teeth, a very rapidly motile organism too. Incidentally, the care of that mouth was all that was necessary mechanically to stop the decay.

That shows the method of transferring the culture from the decay to the microscope. The light is allowed to fall on the mirror, passed up through the organisms and reflected through a prism into the moving picture machine to give us that effect.

This is another, higher magnification, a pure culture, as you see, although you could not tell from the picture here that it was.

A general, mixed culture taken from the tip of that mouth gives us this picture. Here we have the leptothrix and the streptothrix and cyst form of the ameba buccalis, a large number of motile varieties, Bacillus longus.

Organisms taken from a carbuncle, which was nearly fatal to the patient. It is almost identical with an organism taken from the bowels in the next patient, this motile organism taken from the patient's neck. Now in the next case, that of carbuncles, the car-

buncles had been persisting for several years up to a year ago or nearly so. The man has not had a single carbuncle since. His teeth were treated, at which time we found an infection in the teeth corresponding to this in the bowel. Here we see the organism taken from the bowel. You note this characteristic appearance. It just happens to have been developed a little more when we took it from the teeth, but it is the same organism.

Here we have now the organisms from the patient, and this patient had a molar tooth that had been treated with one of the mummifying pastes about ten years ago. He has the same organism growing in that pulp canal, as you see here.

I want you to note the migration, evolution of the ameba which is blamed by Bass and John particularly for causing pyorrhea. This is Endameba buccalis. It has a pseudopodic motion, throwing out its pseudopods in rhythmic form. If this light were good, you would readily see that these pseudopods have their motion rhythmically in a circular form.

These are erythrocytes, or red blood cells, and leucocytes in the field. It is not probable, then, that an organism which could not swim across the field any faster than these could drag infection into the tissue when there are bacteria swimming all about that could go anywhere they wanted to, with the motion they possess.

Now there is another organism found in some pyorrhea pockets, though not so universally. It is able to travel straight ahead in a given direction for a considerable space. There is a strong probability that it could carry bacteria. On the other hand, why should the bacteria wait for it since they, as you see, are swimming all about it in circles—not the streptococci swimming, but there are motile forms in the field. This organism has not been blamed as the causative factor in pyorrhea alveolaris.

This organism will come to a mass of debris and force its way into the debris. Here is a mass of tissue, probably an erythrocyte or leucocyte that the organism has ingested and will carry with it for some distance.

Now an ordinary dirty mouth will show a mixed infection such as this slide gives us. Here you have Bacillus maximus; here a ciliated protozoon, probably a ——— although it is not recorded in any of the literature that we can find; here we have encysted forms of endameboid bacillus, very rapid, motile form, as partic-

ularly this ciliated protozoon. If you will watch it, you will note that it goes through the field sometimes quite rapidly. See this one coming in from below; you note the cilia all the way around the organism. Now if you will feel around your teeth, you can probably feel some of those crawling around. (Laughter.) That is the appearance of an ordinary dirty mouth.

Here we have the organism found in many mouths, with which the viridans has been confused. It has three flagellae and swims in a different form from the viridans; and in a dark field many organisms would be shown that do not show with this illumination.

Here is a dark field showing spirochete forms, some of them very rapidly motile. They may or may not be directly related to our systematic infections, we believe they are related to pyorrheic infections.

This is a study of the normal blood stream, and you will see the erythrocytes or red blood cells passing through the tissues, and later we will inject some bacteria taken from the mouth of a patient who was suffering from dental infection and you will see them as blood clots.

This motion of the frog is caused by the heart beating against the lung, but watch particularly for the movement at the entering of the cell tissue. Here we have the rapidly moving blood in an artery; here, the capillary circulation. There again the capillary circulation is shown very plainly and the large vessels display a spurting motion. There the red blood cells are shown going through the capillaries. Here you have a branching. You see how rapidly that blood is spurting in, how rapidly the blood is passing in through the capillaries. Here again is the capillary circulation; now watch the blood being taken up and going into the veins. This shows it beautifully, going into the veins. Here is an artery, showing that the blood comes almost to a standstill between the heart-beats, but see the capillary circulation in every part of the field. Here is a branching.

Now at about this state we inoculated the frog with two drops injected directly into the heart, into the auricle, of culture taken from the blood stream of a patient. One of Nature's mechanisms is to give us an agglutination of bacteria when they get into blood in which they are not wanted and you will readily see the formation of a clot quite rapidly. This capillary circulation has ceased and a

clot is forming in this blood vessel. You will see it break loose if you watch carefully. This is enlarged again. Now watch it moving. It is slowly clotting. Those are masses of bacteria and erythrocytes in the blood vessel. Now watch it break loose. You have seen this clot form before your eyes, and it is the thing that forms in some part of a patient's body when he has a focus of infection inoculating him and producing an embolic clot, an embolic infection in any other tissue of the body.

Now when we look for the capillary circulation, under magnification, it has almost entirely ceased around this thrombus. This shows a high magnification of those blood vessels, and there is almost no motion, and you see here the great masses of bacteria and the frog erythrocytes en masse in the tissue.

Now while I have overdrawn on your patience, and I must apologize for that, I want to emphasize again the need for the new sense, and repeat again that a new truth is a new sense for with a new truth you can perceive things that you cannot perceive without that new truth and which people who are without that new truth cannot perceive. Let us, then, develop the "infection sense." Thank you. (Applause.)

A DEVELOPING PROFESSION—HOW SHALL WE MEET THE OPPORTUNITIES AND RESPONSIBILITIES OF THE NEAR FUTURE?*

BY EDMUND NOYES, D. D. S., CHICAGO, ILL.

The pressure upon the dental profession from the outside, from the public and from the medical professions, has been increasing of late and will be still greater in the future.

The dental care of school children, the publicity given to medical and dental matters in the newspapers, and especially the great awakening of the medical profession to the causative relation of diseases of the teeth and their surrounding tissues to the serious and sometimes fatal diseases in remote parts of the body: all these are causing a continually increasing proportion of the population to realize the need for dental service and to seek for it.

We are sometimes disposed, and justly so, to resent the interference of a few medical men in directing the removal of pulpless

*Read before the Chicago Dental Society December 19, 1916.