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**Dr Alice Stewart in interview with Max Blythe, November 1985**

MB Dr Stewart, you come from a medical family, was that the basis of your interest in medicine?

AS I suppose it must have been; my mother and father were both doctors, though as an adolescent I thought I was definitely not going to be a doctor, but I was clearly better at maths and sciences than I was at literary subjects at school, so I had been earmarked to try for Girton on the science side. And my father said, 'Well if you're reading natural sciences I should advise you to pass some medical exams as you go,' because in those days you used to have a lot of separate exams, they didn't amalgamate them and so when I finally decided to do medicine I didn't have to go back and do first MB.

MB Right. And what happened? Tell me a little bit about Cambridge. Cambridge must have been fascinating at that time.

AS Well, I enjoyed Cambridge enormously. I only just squeezed in, bottom of the list, I think. I was at Girton, but being a scientist that really meant that you spent all your day in Cambridge. They used to call them the waiting rooms in King's Parade I remember, because we all did labs in the afternoon and, yes, I thoroughly enjoyed it, it was an entirely new life. I stayed four years in Cambridge.

MB And then of course you went off to London to do clinical.

AS Yes. I would have gone back to Sheffield, but just at that moment the doctors at the hospital all voted against having any women residents. My father was furious but he said that would block your career altogether, so I suppose he dug his hands into his pockets and sent me to the Royal Free, which was very good of him because there were eight of us and he was paying for all the education in those days.

MB Quite a sacrifice on his part.

AS Yes. Certainly they were very good in so far as they gave the girls as equal a chance as the boys.

MB What about the Royal Free?

AS I enjoyed the Royal Free because in fact this is really where, I think, when I got to the hospital I realised that they all said that I had green fingers. I thoroughly enjoyed all the diagnostic problems and found that I was much better with my contemporaries than I had been on the more academic stuff, and I left the Royal Free with a ring of prizes which eventually stood me in very good stead. I got the

pathology prize and the medicine prize and the surgery prize, I swept the board almost.

MB You must have had all kinds of ideas going through your head at that time. What did you think....

AS I wanted to be a physician, I knew perfectly well that I wanted to be a physician. But I decided that, and this was cutting across the plans I had, I'd got myself engaged whilst I was in Cambridge, and I decided that it wasn't possible to do this and I'd take up my second string, pathology. And then while I was doing pathology with no less a person than Lucy Wills, she drew my attention to the fact that the medical registrarship at the Royal Free had fallen vacant in the middle of a year and she said, 'Alice you ought to try.' And I said, 'I haven't got my membership,' and she said, 'Well remember all those prizes.' And so, in fact, I then did compete for this job at an unusual time and got it and it was exactly what she said, the clinician said, 'She's only got to sit to get it.' So it was lucky I had won those prizes because then I did get the medical registrarship and I would have gone on, I think stayed at the Royal Free and eventually climbed the ladder, but I got into a bit of a bind with one of the doctors which soured me a bit, but I managed to get on the staff of the Elizabeth Garrett Anderson and then the war broke out so everything was different.

MB Just checking on those dates, the Royal Free, the registrarship, what date did you take that appointment?

AS Let me see, it ends at the beginning of the war so that's '39. So I was there three years, so it would be '36. And I think I got my membership in January '36 and then the Elizabeth Garrett Anderson, I got on the staff of, which of course is a thing that you get elected to, and that must have been Munich time because I was there when war finally broke out, so therefore I was automatically part of sector three. And because the Elizabeth Garrett Anderson was the lowest of the low, Bart's was the grand one, Bart's was sent out to a totally empty hospital to receive all the casualties, and Elizabeth Garrett Anderson was left to look after the people who could no longer come from London and St. Albans. So we had all the best medicine. In fact, all of Bart's students began coming to us, to get taught. And I had, for the first two years of the war, the best clinical practice I ever had, and I think I was just right for it and I thoroughly enjoyed it, the teaching, everything and it was at that point that Witts was desperate because Charles Fletcher had fallen ill, and wanted a locum. And I went there and he obviously liked the quality of my work and after I'd been there and come back again, he then offered me a sort of duration of the war job as his first assistant.

MB Now you came down to Oxford to see Leslie Witts - he invited you?

AS Yes, through a friend of mine. He was desperate for a locum and she, who was his houseperson, that was Dr Newhouse at that time, she said, 'Why don't you try Dr Stewart, I think she'd come.' And I went in my holiday time to do this locum because I thought it would be rather fun. And then I came back to St. Albans expecting to go on as usual - and it hadn't been such fun; it was very bad weather and awkward looking after the children and one thing and another - but then came an invitation now, to stay for the duration of the war.

MB At Oxford.

AS At Oxford.

MB Can you tell me about that because that must have been a very exciting challenge.

AS Well, that was a very exciting challenge until it dropped down because the person whose place I took was supposed to be coming back because he got tuberculosis so a rather shy professor said to me, 'I'm afraid I can't have you after all, there's nothing I can do about this. However, the Medical Research Council had put this little project in front of us, if you'd like to consider it I'm sure I can get you to do this job.' And that was the very first of the surveys that I did which was TNT, trinitrotoluene. The problem was: will intensive shell-filling leave people with jaundice and aplastic anaemia, as it had done in the First World War, because if so, there was going to be a nasty medical mess and they wanted to know what were the factors that could prevent this happening. And I think they all saw it as laboratory tests. But I seized it as an opportunity to say why don't we send a lot of volunteers down and then we'll get the answer quickly. And it worked like a charm and as a result of that - well in the mean time this person didn't come back from the war, so I found myself with both jobs, that of conducting a survey and doing the usual teaching and bedwork in the Nuffield Department of Clinical Medicine and I did that until the end of the war.

MB What kind of measurements were you involved in with that TNT work?

AS Well, it was like this. I hardly knew what TNT stood for so I went to the library and read it all up and then I thought - I was waiting for the plan to come out and I thought you know, the sensible thing is to go to the shell-filling factories, and see this thing for myself. And if I go why don't I go and have some blood tests done on myself and see whether it make any difference? So I thought I'd go and literally go and fill the shells up and find out what this hazard is. And then from there you can see it was a small jump to saying why don't I take some volunteers, and then because I was in Oxford there were plenty of volunteers available over the long vacation. So provided we did it very briskly which did require - I remember Sir Arthur Ellis, who was then the Secretary of the Medical Research Council, he thought it was a very good idea but didn't know that it would work. So we all went up to London to see Oliver Franks who was a temporary civil servant, having been in charge of Queens' College. He saw the idea of the plan and he was very brisk and he said, 'Right you can do it but you must be responsible for X, Y and Z.' He modified the plan very slightly; he would look after the other and we were to go ahead with this experiment. And it worked very well because we were able to see in the individuals, tested before and after, things we'd never been able to do on anybody who we didn't have that control over. And the students were marvellous and they went into high risk jobs and low risk jobs to suit us, and nobody came to any harm because of course they were only there for a month or two months.

MB But that had an effect on the health of the people in a wider industrial change.

AS Funnily enough it was considered a war time secret for some reason. It wasn't allowed to be published, it's as though we had called a march on the Germans that we knew how to stop this and they didn't.

MB That was never published?

AS It was - it's number one and volume one of the newly formed British Journal of Industrial Medicine. Somebody said to me that they find it the easiest reference to look up Vol. 1 page 1.

MB When you were given that, it sounded as though....well, you suggested yourself it sounded as though it was going to be a laboratory based idea. What took you towards the wider survey? I mean, was this you, or had you had views on it?

AS It was entirely me, and I could see the principle that if you were looking for a blood change it would be much easier to see it in somebody who knew what the standard was, so that was really the principle of the whole thing, wasn't it? But what drove me there was that feeling I always had, in clinical medicine you understand the human situation the man the child... Here was an entirely new one, I didn't know anything about it. Therefore I think the plan just germinated in my head like that; go find out, do it, have yourself tested before and after, multiply yourself by ten. In the end, we steered some forty four, I think it was, students in and out. They came to Oxford, they came to our department, had a series of tests done on them and they all went and did shell-filling and then we had reticulocyte counts. You could see what was happening.

MB Right.

AS You could see the haemolytic effect. Actually, it was a wonderful experiment, and of course it gave me a reputation with the MRC. From then on I had a series of jobs of that sort until the end of the war. So when I was offered to become Professor Ryle's first assistant in the Department of Social Medicine, it was because he knew that I'd done these sorts of things and that's how I ended up in the Pneumoconiosis Unit, that was what I was doing at the end of the war.

MB That's what I'd like to ask you about at this stage. You were thrown into the TNT study almost by accident.

AS I threw myself in. Nobody was more shaken than Arthur Ellis when I suggested doing it this way but it was very lucky that we did meet with Oliver Franks who was an academic and understood; I think the ordinary bureaucrat wouldn't have understood.

MB Was there any suspicion in your earlier performance in medicine that you would go towards social medicine, community medicine?

AS No none at all. I despised it horribly. Public health: I had no use for it at all. I wanted to be a clinician who went out and did interesting all the diagnoses and told other people how to get on with it and sort things out. I liked diagnosis. I must say, I wasn't madly interested in treatment. I did treat my patients, but I liked a diagnostic

problem every day. And, in fact, that I think that's what won me those prizes. In the last resort, what do they test the student on, they have given them an unknown patient and tell them to diagnose the conditions. So I had a flair, within the limits of what I'd been trained to do. So I had no conception at all, in fact, I had the greatest difficulty making up my mind to go to Ryle, you know I expected to go back to the Garrett Anderson, and was looking forward to it.

MB This was in Oxford about '44/'45.

AS '45. It must have been '45. The Health Service comes in '46, doesn't it? July '46.

MB Well, the bill came in.

AS Because I just missed it. I wasn't there, I made that decision just before so it must have been between '45 and '46. I think I was actually still with the pneumoconiosis unit in 1945 and went on to Ryle's staff at the end of that year.

MB What was Ryle like?

AS Oh, a marvellous person to work for.

MB Can you tell me a little about Ryle?

AS Well, he was a clinician and of course he was older than I was, and so he never really did learn how to do social medicine, but he knew that he had to learn now from statisticians and listen to their word and not the word of say biochemists as he'd done when he was a good practising physician. And he had a philosophy, he said all the best brains in medicine are going at the wrong end of the stick; they make these wonderful diagnoses, but it's too late. What's the good of telling a person they've got cancer of the lung, there's nothing you can do. Why are we deflecting all the best brains in medicine to this late thing; they ought to be studying the causes. And then you looked at the Public Health Service and you realised that it was just automatically doing jobs that had been given to them by other people. So Ryle said his message was that there ought to be more awareness in the medical profession of the need for semi-clinical studies of the causes of diseases. I'm sure that's what moved him. And he set it up that way to investigate the causes of disease by methods not normally used in other branches of medicine. And it was left to be open, genetic, environmental and he had an idea about positive health as well as illness, all those things that were going round at that time.

MB Was he a dynamic person?

AS Well, what he was so good at as a boss was that he would listen very carefully to what you had to say, he would appreciate what it was, and he would make a decision and ask you about the details of what you needed in the way of support. He would never... he was there like a rock. He would, from then on, accept responsibility. Everybody who worked with him I think recognised this. It was a wonderful atmosphere to work in, that you got what you wanted, he might not give you everything that was certainly not true - but once he did he would assume

responsibility. He taught me that that's very important, when you're in charge that you must hold the can, is really what it comes to. You may have made the wrong decision but you mustn't go and then blame the junior people, it's your fault. He taught me that, at least he taught me how nice it was to work under such a person. He wasn't at all intrusive and when I came up with the boot and shoe trade investigation which I read - it was a leader in *The Times* one morning - and it said something, it reported the findings of a mass radiography survey that pulled out more tuberculosis in the shoe trade than elsewhere. And I knew nothing about the shoe trade and I cut it out and said to Ryle, 'Don't you think that that's the job I ought to be doing?' Because I'd come from the pneumoconiosis unit where there was a dust problem with tuberculosis and here was a non-dusted trade with tuberculosis and I thought those two things fit - my next step. And he wasn't particularly interested in this but he immediately got onto the telephone, and called round to Northampton to find out what it was all about and came with me to a meeting. It was a meeting of manufacturers and trade unions, and health officials, and he put his department at their disposal, with me as a representative. And then he went to the Medical Research Council and got the grant, so I was set up. That's the best boss you can have.

MB Alice there are two stages that I don't want to go through so fast as you've taken them, you've been quite modest. You made a contribution to both these things. Getting them in order, we waltzed into Wales where you want to look at pneumoconiosis. I'd like to ask a bit more about that. In '45 - '46 you went to Wales, you went to Cardiff.

AS Charles Fletcher had been appointed by the Medical Research Council as head of their Pneumoconiosis Unit and he wanted some help, so he naturally came back to Oxford, to his old department and he asked Richard if I could be seconded to help him, and which is what happened. And I went down and stayed in Cardiff on loan from Oxford. Charles and I, I remember we shared the same table so that he was on one side and me on the other - No.11 The Parade, Cardiff. And what we did there was to find out - we were really there to discover the relationship between tuberculosis and silicosis and how to prevent it and one thing and another. Later on Charles did ask me to stay but I said that he and I were too alike and we were both clinicians and he ought to have somebody like people who could analyse dust, and statistics and one thing and another. So it was agreed very amicably that I would always be ready to help him when I could - we did do one of the preliminary studies - but that it would be better if he made up his team with other people. We were too alike.

MB Yes, but you kept in close contact with Charles and you have always been very great friends over the years.

AS Oh yes, we were very close friends.

MB So you came back.

AS Well there was one more little project it was something to do with jaundice and then the war was all coming, it must have come to an end because silicosis was after the war so of course there were a couple of years, eighteen months to a couple of years, and I suppose I did then join Ryle probably in '46 rather than '45. It's very

close to that. I've never worked as a clinician in the National Health Service, that marked my turnover. I didn't realise then that there was no route back.

MB Can I ask about the leather trade, the shoe trade, the tuberculosis there?

AS Shoe-making, boot and shoe factories.

MB Tell me about that survey, will you?

AS Well, that was a lovely survey. This mass radiography had been used during the war mainly for military purposes. Of course, there was much more tuberculosis then than there is now and everybody knew that the National Health Service was coming along, so the Medical Officers of Health, the County and County Borough service were offered as it were the machine, the service, if they had any use for it. And it turned out that the Medical Officer for Health for Northamptonshire decided that he would do a survey of his factories and so he got the apparatus as it were. He advertised in all the factories and then as half the factories in Northamptonshire were boot and shoe, he effectively had a study population on his hands which was boot and shoe versus everything else. And he noticed that there was more tuberculosis and he got, I remember he told me, he got Percy Stocks to check his statistics at the General Registry Office. Why was this important? It turns out everybody knew that the shoe trade had a higher death rate, it was the very first job the Medical Research Council set itself in 1911. But what the mass radiography had done, it had picked up new cases so this was the story. Well, the definition of their excess was newly discovered active cases of pulmonary tuberculosis in the industry. Because it was thought that the tuberculosis, all the extra cases, had come there on the recommendation of doctors: 'Go to the shoe trade, it's a sedentary occupation.' And in fact in the sanatoria, shoe making was one of the trades they taught people. But of course, if you have a county in which half the factories in the country are making boots and shoes there's not much scope for the disabled person, but there was some. And I think what really happens is if you happen to get tuberculosis in the shoe trade, you can get back to your job because it's a light job, whereas if you say had been in steel mills in Sheffield - you've got to think of the pre-war scene when England was manufacturing and not doing what it's doing now - you probably never could get back, you'd have to change your job. So the plan in my head was this: these were new cases so they obviously didn't know they'd got it, therefore the hypothesis to be tested was, 'has this trade attracted more carriers and have they passed it on?' In other words, how is tuberculosis spread in the shoe trade? Now at that time it was considered that there wasn't a spread between fellow workers and if there was, it would be next door workers. And we came away from that study saying 'If you put a carrier into a workshop, however big the workshop is, every single person in that room is at risk.' The tubercle bacilli obviously get out like Brownian movement into the room. And why it was such a nice trade was the size of the factory was reflecting the size of the workshop. Now, in the modern set up that isn't necessarily so at all. There were five distinct jobs: cutting, vamping, stitching, I can't remember now what they were. So each factory had five separate work shops. So a small factory had so many workshops, all small, and a big factory had the same number, all big. So it was very convenient one to work out this number problem on. Of course, I've over-simplified it and we didn't really get onto what exactly was happening as quickly as I have indicated but the basic thing was that we were able to show that to put carriers into a

working population puts everybody at risk. And I remember it was considered rather scandalous at the time. That wasn't how tuberculosis was spread, everybody knew that you could be brought up in a family and not get it. But we did have a little bit of development of the trade as such. We compared the printing trade and the shoe-making trade and we decided both trades had a very slow motion epidemic. We had got these people enured to tuberculosis. In other words, there were selection effects. Familial trades had gradually acquired a strong resistance to tuberculosis but newcomers were still liable to get it. So it was altogether very interesting because I thought well that's probably why we as an industrialised nation had much higher levels of resistance to tuberculosis. We were the survivors from slow motion epidemics. Then I learnt the thing that stood me in very good stead with radiation later on; that though tuberculosis was highly infectious according to our story, there's never been an epidemic. So our idea that a highly infectious disease has to have an epidemic is wrong, and why is it wrong? There are other factors needed to produce the epidemic. And they are first of all that every body who gets the disease shows it, I think you call that penetrance now. Because a lot of people that get tuberculosis just have a cough and a cold and put a little bit of chalk into their lungs and only x per cent actually go down with the disease. So you want full penetrance, you want constant latency and for instance the ideal one is measles - you go to a children's party and seventeen days later all the children go down with measles. And you want that disease to leave those people relatively immune, those who don't die, so the epidemic dies down because the bacterium is working against the selection. So when you realise that, you realise infectious diseases don't necessarily occur in epidemics. They tend to occur in epidemics because they attack children who offer you the right material for this. But tuberculosis doesn't occur in epidemics and it shows how it can be infiltrating in a society and nothing there to show for it. You see work was considered safe and it was safe when you looked at it. So I think that was quite unconsciously wonderful preparation for low level radiation. But that wasn't to come until much later on.

MB Alice, when you'd finished this boot and shoe trade work, that took two years?

AS Two or three I think, yes.

MB That was a massive confirmation of your interest in social medicine.

AS Well it had, as I always say, like all good surveys it had ramifications. And first of all we much engaged the attention of the Medical Officer of Health for Northamptonshire and so he wanted me to do studies about - I've forgotten now the name of the town that was full of Scottish people that had come down.

MB It was Corby.

AS Corby. So he wanted a study of Corby infant mortality, compared with the town as a whole. And then branching out into 'how does tuberculosis spread between adjacent houses?' We did a study of that in the City of Northampton. And then we wanted evidence that there was recruitment - that people who came into the shoe trade did have more tuberculosis, we needed proof of that. And that put us into the CMBs, the Civilian Medical Boards study. And that became the next big ploy because I suddenly realised that it had been a census, a marvellous medical census of everybody



between the ages of eighteen and forty five. As part of the orderly procedure of the war, every single person between those ages had to report to, they were called Civilian Medical Boards, to go through a medical examination which left recorded what job they'd been in, what age they were, what height they were, the results of passing tests and also whether they found anything as a result of these tests. The sad thing is they had gaps in it. You see, if you were a cripple and I had a brother who was bed ridden, my mother had to report him as a person. Why couldn't he be called up, because he was dying of a chronic disease. They didn't keep that record, they just kept the man's name and pushed on. So I've always said that if the people had been more aware of the requirements of epidemiology, it's power to resolve problems at that time, that census that took place - you realise it wasn't really a census but it was a call up procedure - would be a rich mine of information to this day.

MB But still there was a lot of data.

AS Even though it was a torn fragment, we made great weather of it and were able to show that there was more tuberculosis in the shoe trade. It is a trade that attracts carriers and so we went from there to study characteristics of other trades so that took up some time. And the Medical Research Council was paying for this sort of thing, which was lucky because in the meantime Professor Ryle died and the Hebdomadal Council of Oxford [University] sought the advice of the Medical Faculty about whether to continue this department. It had been put there on a ten year trial basis. And I suppose the other departments naturally enough thought that experiments were a better investment than surveys, and of course ten years isn't really long enough for a department to prove its worthwhileness in a hostile environment. So almost overnight they decided they couldn't completely shut down the subject because Lord Nuffield was still alive and it was he who'd given the ten year grant to get the thing going. The University provided the professor, so what they did, they cancelled the professorship and they said they'd have a Social Medicine Unit, it wasn't grand enough to be called a department, it was a Social Medicine Unit and it consisted of one person, which was me. Overnight I suddenly found myself called 'Reader in Social Medicine,' and what were my duties? My pay was the same but I was to do such teaching as the clinical school required. I was given two rooms and they didn't want me to do any teaching, the clinicians were quite happy without it. And the only assistance I had were two people who were coming to the end of their grant on this CMB study which were David Hewitt and Josephine Webb. And so there we were, but we wanted to continue working as a team and I can remember quite strongly I said, give the university a bit of time and a few successful surveys and it will see it's made a mistake and it will go back. I don't know how naïve you can get, but at any rate we sat down and thought up the plan that led to the radiation story. But in the meantime I, of course, had to do something, I had to point out to the university I would not stay in this job unless they gave me a statistician. So we had a bit of a battle about that and fortunately Professor Witts was on my side, and I think we also paid for David Hewitt's salary for six months by selling the furniture which the Nuffield people didn't want. And then we got some temporary grant from - do you remember when the hospitals were being dissolved - there was some money left over. I remember, very interesting there, voting where this little bit of money was to go and one of the pleas was to provide me with a statistician and, if you please, the Medical Officer of Health voted against it. He said he wanted the subject to revert back to his department and stop being academic. It was interesting when you think of it and then I think Professor Witts

must have put on the pressure, and the university from then on said I had to have an assistant. So there were two of us.

MB That was a very interesting area, you landing this very unusual position of having temporary staff or staff finishing appointments and being a solitary reader in a curious unit, badly funded by the sounds of it.

AS Well I had six hundred pounds to pay for a secretary and to do the gas bills per annum, that was my total funding.

MB What was the size of Ryle's department before that had been broken down.

AS Well, he had been quite big. He had two bio-statisticians, Ian Sutherland and Doctor Roberts who he'd collected from the London School of Hygiene. And he had a project going for studying the health of children and so he had a health visitor and some clinical assistant doing exams. He'd been set up in quite a nice little department and, of course, while he was there, the Nuffield Provincial Hospital Trust continued to give him some little bits of money when he needed it. And I suppose that's how he got a first assistant, which was me. No, we both lost the building, of course, straight away. It was a sop to sober us, wasn't it? In fact, I know this did happen. The medical faculty voted against the department. They didn't say that, they said, 'Our shopping list begins here,' and social medicine was right down the list. So they knew perfectly well the shopping list was going to be cut off half way down, which it was. And I got a call from Janet Vaughan saying, 'Alice I wanted to tell you so it wouldn't be too much of a shock for you in the morning, and I also wanted to tell you that the people had said some very nice things about you personally, but they said they'd decided that experiments in social medicine were a failure and they were going to stop the whole department.' I went out with a friend that evening to sort of celebrate this great moment and decide how I was going to struggle back and what sorts of things I was going to do. But Janet Vaughan was trying to call me back, why, because some member of the Hebdomadal Council said, 'Look, you can't do that because Lord Nuffield is still alive. You must keep the thing going, there will be too much of a fuss.' And that I didn't realise, I was really being conned into being, by keeping me there, they were able to tell the world. They'd just tricked me. I should have blown their gaff, shouldn't I? And I think almost anybody else would have left. But I really was, by this time, quite bitten with the subject. I'd come round to thinking that this was where I ought to be. And anybody who had a diagnostic flair ought to get away from the ground that had been well trodden by clinicians and go out into this new world, there's a fish in every pond.

MB Already, a massive amount of work had gone on, but that was before the radiation work started.

AS Well, it isn't massive, you can see it now. When you think of it at the time it was coming up in papers, wasn't it? It was hardly yet in print.

MB I'm thinking of your own contribution, all the surveys, there were lots of them.

AS Oh yes. I did a lot of things before.

MB All that before radiation. When did radiation - when did the idea, the impetus to move into that field actually arrive, '49?

AS I must now tell you that it's rather interesting, I'm very well known for the radiation, people think it's been the whole of my life, to me it's the end of a long story. I was a clinician, won my spurs by getting the FRCP, I was the first woman to do that before the age of forty and I was still in single figures, I was the ninth woman. I've never had any recognition of anything since. The funny thing is that everybody thinks I started with radiation and public health, whereas in fact I'd almost finished my career before I'd started on it.

MB The conversation today points that very clearly, I think. Would you take me through.

AS Yes, I'll tell you how the radiation .....it was entirely this awkward position we were in. We realised that if we were to go on, the MRC grants were winding up on the CMBs and we must get a new subject. So the obvious thing to do was to go for a disease which was on the increase and see if there was any excuse for doing a survey, that was our first plan and I can remember looking round for diseases. Lung cancer was already on the go, Jerry Morris was doing his cardiovascular diseases, Ian Sutherland was dealing with poliomyelitis, all those three were on the increase and the fourth one was considered to be too rare to do anything, leukaemia. However, we said well, we'd better have a look at it, so David Hewitt wrapped a wet towel round his head and went and looked at all the vital statistics. And he was the first person to notice that there was something very odd going on in children. Here was a disease that was increasing at that time, faster than lung cancer at an unprecedented rate for any known cancer. We now know that every single country in the world went from low, pre-war levels to their high levels of today but they're high but steady so they don't cause anybody any anxiety. And people have forgotten about the low pre-war ones or the doctors tend to say, 'Well, in those days doctors couldn't diagnose the condition.' This is absolute nonsense, there was something really happening.

MB A real escalation.

AS But we were on the middle of it you see, and it looked as though there was going to be some sort of epidemic. What David Hewitt noticed was that this increase had not affected...before the increase, going back to the thirties, if you looked at the leukaemia statistics for young children, it was a curiously flat frequency. Most causes of death in children are far and away most common in the first year of life, then they come down very steeply and flatten out and leukaemia is just chugging along the bottom line. But the rate was almost the same for a one year old, two year old, three year old, four year old, five year old then five to ten and you went on. And the increase had not affected the first two age groups, the nought and the one. Then there was a big jump and the next two age groups, as it were, had been clobbered and then it came down. So here was this curious thing called 'early peak of leukaemia mortality.' And it was that, that we said nobody seems to have any ideas about what it was. So I fudged up a grant application which was that there might have been a pre-natal event which had been missed by the obstetricians but might be resuscitated if we could go and question the mothers. Well, of course, what were we proposing to do? A minimum of five hundred cases, this was David Hewitt's statement, which were to

be compared with a minimum of five hundred other dead children and five hundred live children and they were to be matched for age and sex. You can see how soon out of that grew the idea that we would take all malignant diseases because they would be our case group and our control group and we would match each one with a live control. Where were we going to get the live controls from? We found we couldn't ... we knew we could get the death certificates and in fact we ... well, I'll tell you about this in a minute. But we were probing about and discovered that the obvious best place for this was the birth registers held by the public health doctors. So that was what the grant application said. We proposed to collect together five hundred cases of leukaemia and we think we can do this by going back three years, and all the other malignant diseases will be controls and we'll pair them all off and we'll do paired interviewing. And we would farm it out to the local authorities. Well, I suppose I should have guessed that to look backwards and to have multiple death collectors was not in the mid-fifties, and I repeat, not fashionable, it was asking for trouble and in fact we didn't get the grant. But for some peculiar reason I was given a thousand pounds by the Lady Tarter (?) Memorial Trust and I was given it by somebody who'd attended the committee at which the decision had been made that we shouldn't have the grant, and I suppose he thought it was quite a good idea because nobody had any ideas about what to do about leukaemia. And he said he could engineer this money in my direction if I thought it was any help. So I said yes, and because of the very peculiar position that I was in, I really had nothing to do, I had recently appointed a statistician and Webb had found that she could remain on the external staff of the Medical Research Council indefinitely. She was rather older and they weren't going to sack her, she could stay and be my assistant. So we said, well, we'll go it alone. So we spent the thousand pounds getting the death certificates, sorting them out into the local authority packages, inventing a questionnaire and going to the local authorities, why, because they had the ideal controls. So all I did was, I said right, well get the death certificates, and I'll go and see what help I can get. It's going to be case controlled so it didn't matter if you got everybody, we had all the deaths, three hundred in every year so we had about nine hundred leukaemia deaths and about a thousand. Yes it was eighteen hundred so it must have been about equal numbers. And I went back to my home town where I knew the Medical Officer of Health and Doctor Webb went up to London to seek the help of people in London County Council. And he was very helpful. I showed him which cases Sheffield had had, leukaemia and others, and said, 'Could we get controls?' And he showed me the registers and how you can do it, yes that was alright, and he even put a maternity and child welfare doctor at my disposal and said you can have her services for one day a week. So it was agreed between us that I would try out this procedure with him. It worked like a charm and of course he then used his influence to introduce me to other people and eventually the whole thing caught on and in no time at all we traced eighty per cent of these children.

MB You got a network of medical officers working for you.

AS Two hundred of them.

MB Quite sizeable.

AS And you see we took advantage really of the rarity. Now, if I'd gone up to them with all the congenitally defective children, they'd have laughed me out of the

room but to go up to a town the size of Sheffield with fifteen cases, I think there were, five in each year, it was perfectly manageable and he thought it was interesting. And I think what added to this was the changeover to the new National Health Service had deprived medical officers of health of their hospital duties and they felt a little bit without things of clinical interest, so the idea of cancers was interesting to them. But anyway it caught on.

MB And you soon began to get patterns emerging that were exciting.

AS Well, Webb wasn't quite so lucky in London but it was what she wanted, they said right we can give you the births and that but we'll ask you to do most of the interviewing. So she was meantime collecting cases in London and some were coming back from Oxford. And the first package of fifty six, it was either, fifty six or thirty six, and we'd made the arrangements, each medical officer of health was to be given a list of the children and all the instructions. Each envelope was to contain two questionnaires, identical, and a copy of the death certificate and instructions of how to get the control and a blank list of potential controls. And these came back to us and in the same envelopes that they were sent out in a pair. And they were told that if the mother refused the interview they were just to say she refused because we didn't want to press anything on her if she didn't want it. But if they could get the pair they were to go as soon as possible to the next child with the same interviewer, that was the only condition that we laid down. And in the first as I say thirty six, two things to notice - the two children were like as two peas, they'd been matched for sex for locality and age, date of birth, and their medical histories seemed to be almost identical till you came to the ante-natal period which the mother had been asked about various things that had happened there. And it stood out like a sore thumb that the obstetric x-ray, the abdominal x-ray was going three to one cases. And not the chest x-rays and not the other x-rays and not x-rays in the mother's lifetime and not x-rays elsewhere. And there it was.

MB Incredible correlation.

AS Well, you always need a bit of luck as I say. But looking back, I can see what had happened. Obstetricians thought that radiation was perfectly safe so they found it very convenient to take an x-ray shortly before delivery to anticipate differences. What they were doing was what we can all see today, they were putting thousands of normal children, giving them a fixed dose of radiation at a fixed age. Right, you couldn't ask for more ideal things to find out whether radiation was doing any harm, but you would have never found it looking forward because it was so rare. We'd taken the concentrated solution from that end and were able to chase up what the difference was. But we hadn't found the reason for that early peak, that still is, in theory, it's a mystery but I think, it's my present hunch, that I think I know what it is.

MB We'll come to that in due course.

AS Yes, but what we'd found applied equally to our dead controls, malignant diseases, as to our leukaemia. So from then on they become one group. All malignant diseases were in the boat as far as the radiation hazard was concerned, equally. And we now know, we can look back and say approximately five per cent of these children over the years have been caused this way. Equal for each diagnostic

group, it's not specially for leukaemia and not specially any other tissue. The x-rays are much safer today than they were, all this lies in the future. Why did we go on? We published a report.

MB When did you publish, Alice?

AS We put out a preliminary report September '56. That was done to help us and it did. No doubt it made it easier, data collection zoomed ahead and I could hardly keep pace with it going to (?). I spent the thousand pounds knocking on every brass knocker in the country and they just set to, I think they thought I'd come from the Ministry but none of them (?). The word was going round that it was a good project.

MB But as you were finding these results you were getting into a rather difficult political field.

AS Well, when the result came out finally in '58 of course nobody was prepared to believe it, it must be wrong. But in the interval between the preliminary report in '56 and the final report in '58, that was meant to be the end of our contribution to this story, they'd started doing prospective surveys and they started doing animal experiments. And they by 1960, these were showing to have a drawn a blank so then everyone was quite certain we'd done the thing wrong. But we in the meantime had noticed something else about our case-controlled difference, that was one reason for it being wrong. It should have been leukaemia if it was genuine but it was even. But one thing we were aware of was that children who formed that peak I told you of, if you divided those children into x-rayed and non x-rayed, you got a shift of the age that you could recognise. Age differences were very difficult to recognise in our sample because it was three years deaths over a wider range of years. But we could see this so we knew that all this about biased recording and David Hewitt had worked out how big would have been the error for this to be so, and it was astronomical and we were pretty certain.

MB David Hewitt was pretty reliable.

AS A real live wire, he knew everything, he was frightfully good. And we weren't happy with this but it was his idea, the next one, he said, 'Look it's very unlikely that all children's cancers are initiated at the same time as you take an x-ray, which is the third trimester of pregnancy. Therefore if we peg on, collect more data for the next years till we've got all the children who were born in 1953 who died from cancer before the age of fifteen, then we would have the equivalent of a prospective survey on a much bigger scale than anybody's properly done it, and we would also be able to take the age distributions of our x-rayed and non x-rayed cases and compare them and not bring in the controls. So that is why we settled back to re-open negotiations with all the medical officers of health and called a little meeting and got forty of the principal ones, and explained exactly what had happened. And I said, 'I'm asking you once again to co-operate voluntarily and would you like to be officially represented in the survey.' Well, they all opted to go on on the same basis as before, and they would co-operate. And we've been doing that ever since. And that is why we've now collected an enormous amount of information about these children and incidentally enormous numbers, we now deal in thousands, twenty

thousands of children's cancers and we can see patterns that were totally invisible before.

MB Alice, how do you want to tell me about the development of that research, obviously there's a mound of it, and in the time remaining to us, we've got to be fairly economic in discussing it.

AS Why don't we jump to the very latest thing that's happened because a new dimension has come into the story as a result of the National Radiation Protection Board having gone right across the country exactly the same areas covered by the Oxford Survey, England, Scotland and Wales, and has produced an estimate of the terrestrial component of gamma radiation outdoors for every ten kilometre square of the country. Now, we had all the cancer cases in every ten kilometre square, all we needed was populations. We couldn't get them into squares but we could do them by the old fashioned, local authority areas which recognised, the squares add up to 1,828, I think in England, and our local authorities added up to 1,792. So we collected together the births from 1944 onwards, '44 to '79 and '53 to '79 for the cancer deaths and in the end we decided to amalgamate - this is temporary - amalgamate the squares, districts we call them, centred on ten kilometre squares of which we think we've got a sufficient size. There are nine hundred and eleven of them, so you divide England and Wales into nine hundred and eleven. For each of those districts you've got a background radiation dose, you've got all the live births in every year from 1944 to '79 and you've got all the cancer deaths from '53 to '79. So you actually have three hundred and forty seven million plus years of follow up of twenty two thousand three hundred and fifty one cancer deaths and you can put them against their background radiation. What happens when you do? It's upside down. The highest levels of background radiation are in the west and the north, the lowest are in the east and in the south, and the cancer is highest in the east and south and the lowest... So ample proof that radiation does you good. However, of course it isn't true. So what we did, the first step was to divide the whole country up into a hundred kilometre squares, you see we had the little tens inside there, and said we won't go outside the boundary of a large square, we'll just take what dose range there is within the squares. For instance, Greater London is within square TQ and there were sixty-two districts there and the dose range went from twenty to thirty-four. In Liverpool, I can remember that off-hand, which also includes Manchester. By the way there were 4,684 deaths in the London area and in the Liverpool area there were about twenty-two thousand, and their doses go from twenty to forty-two. And if you take them this way, and then you see it's going up the dose. And now, so we did it for right across the country, now not all of them go up, there's some jiggle but none of them go down significantly, half a dozen or so go up, they're the bigger ones, and the weighted average for the whole country is in a positive direction.

MB The pattern basically fits.

AS So there is definite evidence of a radiation effect on this analysis alone but the analysis has also taught us that there's something geographically going the opposite way, therefore we must look and examine this. So we found out what it is. It's the worse climate and the lower incomes up there produce more pre-natal, pre-cancer deaths which are never recognised because they go down as infection deaths than they do in the south-east. Why do we know this? Because in the meantime, the Oxford

Survey has been able to show that during the interval between inducing the cancer and getting the disease, you become increasingly infection sensitive. And in cases of leukaemia this change is so great that by the end of that period, if you compare it with a normal child, the child's not yet got leukaemia, it's just in the last year before, he's three hundred times as likely to die from an infection as his contemporary. We also found that the third trimester of pregnancy is a relatively late date to initiate a juvenile cancer, so they're all pre-natal. So what I was telling you about the areas is all place of birth, because what you really want to know is where is the pregnant mother and they don't move about nearly as much as the rest of the population. So you have some chance of catching it. And the truth of the matter is that George Neil has not only caught it, but fitted it into a special regression analysis which brings out our case-controlled pairs. You set all the standards by the controls and then observe the effect of social class, pregnancy illnesses, pre-natal illnesses - what else have we got - clusters, geographical position, maternal age. And you do an analysis in which you look at each one of these in turn and control for all the others, and when you do that you come out with - there are only two carcinogens in the story, the others are all factors playing on the situation - the two carcinogens are the background radiation and pre-natal x-rays. And to bring you what is the latest estimate, pre-natal x-rays are themselves very dangerous individually but there are only fourteen per cent of the children affected so they only contribute 6.6% to the story, that was the update figure of 5% I gave you, but the terrestrial background radiation, everybody's exposed to it and it is only twenty per cent of the whole background radiation, so what is the weight of the whole background radiation and it lies between seventy and ninety per cent. That's today's finding.

MB Alice, have these findings been well received?

AS Well, wait a moment they're not yet in print. There's been murmuring about this. We first gave a showing in Pisa in September to release the story. George has since improved his regression analysis and we did it at the meeting that the Friends of the Earth had the other day at the Hammersmith Hospital, and I was talking about it in Sheffield yesterday so it's all at a talkie level. The meeting at Pisa was very interesting, the younger radio-biologists were prepared to think there might be something in this, the older ones said impossible, quite impossible. So when I said well, we've found something, haven't we, what do you think it is. I don't know they said but it's impossible. They went into all their calculations about radiation and its effects. Why is it impossible? Because ICRP has meantime laid down what to expect in this situation and it's laid it down on the basis of the A-bomb survivor population or patients treated for ankylosing spondylitis, or other high-dose studies. And so I think we can add one other finding and that it isn't safe extrapolate from high to low, you'll get the wrong answer. No, we're going to have a tremendous fight to get this across. I'll tell you, there's a totally second story cutting across it. Background radiation in one form or another is far and away the most important cause of childhood cancers. But there are clusters, genuine conglomerations of cases. Our definition of a cluster is a very precise one: it says we've got these cohorts, the country divided up into 911 areas, thirty-six years of births so we've got regional births cohorts, we've got 32,796 haven't we? Now, each of those has been followed for a given length of time for cancer deaths, and so we know the expected number assuming an even distribution. You do this by a Poisson's heterogeneity test. Actually, it's something like twenty-two thousand of those cohorts never have a



cancer death. So you're left with the remaining ten thousand and in those you can show that the distribution, there are what we call clusters and holes. In other words there are cohorts who've got too few and cohorts that have got too many, and this is significantly too many and significantly too few - it's nothing to do with those margins of error. And so it says there is another factor at work which is either producing holes or adding to cases, and we think it is holes, because you would only need an epidemic disease to sweep across the country and pick on the children who are very sensitive because they're cooking leukaemia unbeknownst to everybody to remove those from the scene and then the ones that remain look as though they're clusters. That is for research, that is only a guess.

MB This is part of your next programme. You've just had a large grant to do this.

AS We haven't got the large grant to do that so we shall be kept busy. The large grant is to pick up our occupational studies which is a little cadenza performed in America and Birmingham to say that children are not the only people to suffer from the cancer effects of low level radiation, the workers are too. That's highly controversial but things are swinging slowly round in the direction to believing this must be so, and so we've got a busy programme in front. The EEC is backing the cluster story and there's a big grant coming for the occupational, so I'm busy trying to persuade Birmingham to have a Radiation Epidemiology Unit attached to the Department of Social Medicine. And it sounds as though we've got plenty of money but we're out for balanced money. We've got too much, no, not too much money we've got the right amount of money for the occupational study and too little for the others. But we're hoping to set ourselves up and there's a job going for somebody because everybody's frightfully pleased about this idea but they realise at my great age that they'd better immediately advertise for somebody who could be an understudy for me at a moments notice!

MB I hope your work Alice goes on a long time, we're coming to the end of a very long interview.

AS All right but that's the last notice. Strictly speaking I've got a job for life but the urgent need is to find somebody to carry on when I stop.

MB I hope you see it through, thank you.