LYMPHOID HYPERPLASIA AND PREVENTION OF OTITIS DUE TO BAROTRAUMA (AEROTITIS) WITH RADON

Major Edmund P. Fowler, Jr., Medical Corps, Army of the United States.

Examination of American soldiers in England reveals that they are even more prone to develop pharyngeal lymphoid hyperplasia, secondary eustachian salphingitis and consequent otitis media on this island than in the United States. Whether this is due to climate, or living conditions, or something else, is difficult to say. A very high percentage of flying personnel come hospitals with a history of recurrent acute catarrhal otitis media. In one Genreral Hospital, 8% of ground personnel and 22% of flying personnel had a history of recent otitis when examined. Nearly all of them had sufficient excess lymphoid tissue around their eustachian tubes to account for this.

Since Crowe and Baylor's article (1) on the prevention of deafness in childhood using radon in the nasopharynx, the John Hopkins work has been repeated in New York (2) as well as several other cities (3) (4), It seemed reasonable to try radiation on soldiers, because their otitis occurred with excess lymphoid tissue which resembled that seen in children with the same condition. The use of radon appeared particularly applicable to airmen, because interference with normal tube function, by even a small amount of swollen tissue, is likely to cause trouble when they change altitude.

Through the asupices of Professor Barclay of Oxford, contact was made with Professor Russ of the Middlesex Hospital, who arranged for the delivery of radon at regular intervals, from the Central Radon Institute Barton-in-the-Clay, Berks. Treatments were begun in December 1942 and up to March 1944, 220 patients had been treated. The most convenient dose for the laboratory to ship and to put into the capsules provided was 75 millicuries per capsule. The capsules are made of platinum 0.65 mm thick and measure 3.5 mm by 15 mm. They are attached to a semi-maleable 18 gauge wire, 14 cm in length. The radon is inserted very much as is a nasopharyngoscope, the capsules (totalling 150 millicuries on the first day) are passed along the floor of the nose and then separated by placing a small piece of rubber tubing over the insertion wores outside the nostril (fig 1 & 2). They are left in place 25 minutes the first day. Since 150 millicuries is equivalent to 150 mg of radium element, 25 minutes gives a dosage of 66 mg. hrs. or two gram minutes; that is, approximately the dosage recommended by Crowe (1). The radon capsules as a rule lie very near exuberant lymphoid tissue on the medial side of the

torus. For convenience they are considered as a single source of emanation in estimating dosage. However, since the capsules are separated, the total effect of 66 mg. would not reach any area in the nasoparynx. The designation 66 mg. hrs. therefore slightly exaggerates the dosage that actually reaches the nasopharyngeal walls. The exact tissue dosage is not known because the applicators will necessarily lie at different distances from the tissue in different individuals so that the strength of the two applicators added together and the time that they lie in the naspharynx is used as the most reasonable and safest approximation of the dosage.

Since radon decreases one-half of its strength each 3.85 days, the time is increased every day until there is very little activity left in the radon, i.e. not over 10 days. Table 1. The treatments were originally given at 6 weeks' intervals until 4 to 6 doses had been given. There was rarely any evidence of improvement until after the 3rd treatment. If a patient had a cold or an active otitis at the time of his appointment for treatments, half the usual dosage was given, that is 33 mg. hrs. instead of 66 mg. hrs. Then if no reaction occurred, a second 33 mg. hrs. was given in 2 or 3 days. Occasionally there was increased stuffiness in the ears without objective signs following treatment, but twice in patients with active nasopharyngitis, definite acute catarrhal otitis media with fluid levels developed. Myringotomy was not needed in these cases and the fluid disappeared in a few days. When the interval between treatments was reduced to 3 weeks, there were not untoward results. This was expected, for much more extensive radiation is given to patients with neoplasm without permanent effect on normal tissue. A small series has been tried giving 100 mg. hrs. at 4 weeks' intervals, for two treatments. Sufficient folow-up has not yet been obtained on these patients for inclusion in this paper, but the method seems to be satisfactory.

Shrinkage of the nasal mucosa, even temperature and sunny weather, would undoubtedly have helped some of the cases treated with radon, but most of them had been treated extensively without relief before being sent to the 2nd General Hospital. Some of our airmen went to Africa and they were quite well until they came back. Succeeding attacks were often more persistent and more often resulted in suppuration than first attacks. Sulfonamides rarely had any effect on the sisease unless it was suppurative. Even when suppuration cleared there were many cases of residual catarrhal otitis following the use of sulfonamides. This seems to be particularly so if inadequate dosage was given or if the drug was not continued for a sufficiently long period, or if the adenoids were very large.

Experience with deep X-ray therapy (2) has shown that it affects lymphoid hyperplasia in the nasopharynx very much as does radon, but patients must take many more treatments. X-ray takes longer and is more difficult to apply accurately to the eustachian tube region. It is more likely to involve surrounding tissue and produce other symptoms such as a mild parotitis, erythema of the skin or dryness of the throat. Radium element on the other hand can be used if available. The 25 or 50 mgm capsules often used in gynecological practice are convenient for this work (2).

The greatest difficulty in the Army has been to get the men back by appointment for enough treatments. They feel better and they don't come until a recommencement of their symptoms, or they move so that they are no longer evacuated for sickness to the original hospital before the course is finished. Many have been sent back to the United States becuase their nasopharyngitis or sinusitis seemed to be uncontrollable in this theater. These are the reasons so many cases have received incomplete treatment in our hands.

In these cases who have received sufficient doaage, and who are not plagued by chronic nasopharyngitis and sinusitis there has been a gratifying percentage of successes. (table I

Unfortunately, many medical officers and patients expect too much from the treatment. Radiation is not a "cure for deafness.' It obviously will not improve the hearing very much if scars and adhesions interfere with the movement of the ossicles. It cannot be expected to work if a chronic sinusitis repeatedly bathes the orifices of the tubes with pus and reinfects the middle ears, or if a chronic purulent otitis is present although, at times, it does seem to help even these cases. It rarely is of benefit if severe allergic rhinitis is present.

Airmen with subacuts eustachian tube blockage can get along perfectly well on the ground or even at low altitudes, but as soon as they fly high, or are subjected to rapid changes of altitude their eustachian tubes close so that they cannot be opened. This otitis barotrauma produces anything from a mild catarrhal condition in the middle ear to an acute severe otitis with or without rupture, and may go on to an acute purulent process. None of these conditions wouldd evelope if the tubes had not malfunctioned in the first place. Most of the malfunction of the eustachian tubes is due to swollen tissue within the tube. This tissue is not always apparent at the orifice. In addition to lymphoid tissue, there is often swollen glands, oedomatousmucosa, or sub-mucosa, as well as hyper-secretion bleeding the tube. The cold air of high altitude often causes hyper-secretion in the nose which bathes the tubal

orifices and blocks or irritates them. Apparently radiation reduces activity of glands, shrinks the cedema and has, in addition, a specific effect on hyperplastic lymphoid tissue. It is probable that the radiation has a beneficid effect on the infection present as well as producing a shrinkage of the lymphoid tissue itself.

Some physicians assume that adenois are rare in adults. American soldiers after a few months in England often have so much excess lymphoid tissue that as soon as the mouth is opened it can be seen bulging from the posterior pharyngeal wall, or behind the posterior tonsilar pillars in heavy bands. It is particularly prominent following a virus pneumonia. When it can be seen on the phayyngeal wall below the pallate, it is inveriably present in the naso-pharynx above. It is often difficult in the forces to obtain a smooth narrow metal tongue blade and the small well silvered mirror and good lighting necessary for proper indirect examination of the nasopharynx; likewise, it is often difficult ot obtain a good nasopharyngoscope with a wide field and upright image for a direct examination. If they are used in every case, it is surprising how many soldiers are found to have large lymphoid masses in and about the carilagenous portions of their eustachian tubes. Out of 2337 new patients in our Ear Nose and Throat Clinic well over 1/3 had swollen lymphoid tissue in the nasopharynx. Of these radon treatment was begun in 220. A summary of these cases is given in Table II. Other details are as follows: 24 had adenoidectomies because radon rays do not sufficiently reduce large masses of lymphoid hyperplasia in the midline in the dosage given. Of the 2337 patients, 62 recurrent otitis due to barotrauma sufficiently severe for them to be sent for special treatment. 9 of these have been sent back to the United States after one or two treatments, because in addition to otitis they had intractable naso-pharyngitis or sinusitis. A few have been lost at follow-up, the remainder are still under treatment. 79% of the airmen who have had sufficient treatment are back on full flying status, (See Table II); that is, 79% of airmen who have had two or more episodes of severe difficulty clearing their ears are now quite comfortable and have not been grounded for two months or more. Most of them had aero-otitis after every flight before treatment. None of the flyers had much residua deafness by the time they readhed a general hospital, so that is ti difficult to give a graphic picture of their improvemer However, the fact that they are now flying several times per week, without trouble, is significant. Some of them are now dive bombing in fast planes. Of the 6 men who did not return to flying, 2 were enlisted men grounded for administrative reasons, and 2 had a residual nerve type deafness sufficient severe to keep them from passing the hearing examination necessary for return to the air. Their non-suppurative otiti media cleared, but the high tone loss did not.

The chronic non-suppurative otitis did not subside completely in one case, although he was able to carry on in ground duty. One had had severe recurrent nasopharyngitis in this thearer and was boarded to the United States. It is probable that he would have flown here could he have stayed after the treatments were finished.

As for the control group, ground personnel, the results are not quite so clear out. It is difficult to be sure that some of the 75% who stopped having recurrent otitis would not have got well without treatment. It is also probable that eventually some of them will have recurrences. Almost 5 years of experience with recalcitrant upper respiratory diseases and secondary otitis media treated in this and other hospitals makes one certain clinically that radiation is the treatment of choice if adenoid tissue on the lateral nasopharyngeal walls blocks the eustachian tubes. There is also no question that if only cases without active severe nasopharyngitis of sinusitis had been selected that the percentage of improvement would have been better. The cases who had otosclerosis or nerve deafness were treated because these diagnoses are very difficult to make and occasionally some improvement was obtained even when these conditions were present. This is believed to be due to the subsidence of a superimposed tubal catarrh. In spite of the fact that no accidents have occurred with the relatively safe dosage used, it is believed unwise and dangerous for an otolaryngoligist to attempt radiotherapy of the nasopharynx without the continual quidance of a qualified radiotherapist. On the other hand, where such control is available, treatment of the lymphoid tissue about the eustachian tube withradon or radium is simple, relatively inexpensive and easily learned. It is infinitely more efficacious and permanent than catheterization, polizeration or bougienage. These should bereserved for the few cases in which they are indicated. (Farrior 4). Centers for the more extensive utilization of the radiation treatment for lymphoid hyperplasia in the nasopharynx should be set up.

A report is made at this time because experience with ground personnel and children has shown that lymphoid hyperplasia in the nasopharynx predisposes to otitis media which can be controlled with radiation. A limited experience of flying personnel shows, as might be expected, that this modality also tends to prevent recurrent otitis due to barotrauma (aerotitis) when it is due to swollen tissue in and about the eustac ian tubes. In practice it has put men who had been previously grounded back i the air able to fight. We need them there NOW!

The author was assisted in the examination and treatment of these patients by Captain Paul M. Osmum, U. S. Medical Corps, and in the details of radiotherapy by Lt. Col. Robert P. Ball, Chief of the Radiology Service, 2nd General Hospital. To These men acknowledgement and thanks are herby rendered.

TABLE I

		66 mg. hrs	11 mg.hrs.
June 1	10 a.m.	26	39
1st Day	4 p.m.	27	42
June 2	10 a.m.	31	47
2nd day	4 p.m.	33	51
June 3	10 a.m.	38	57
3rd day	4 p.m.	40	60
June 4	10 a.m.	45	68
4th day	4 p.m.	48	72

Table I, showing increase in dosage time necessary each day with applicators containing 150 millicuries of radon, on the first day. Such a table is made up each time the radon is delivered so that proper dosage for each date is available without calculation.

TABLE II

Total Airmen with recurrent otitis media treated with 200 mg. hrs. or more and on whom follow up is complete.(all of these cases were aerotitis except 3) 29

Number back flying 23* - [illegible]
Total free of otitis 28 - [illegible]
* one pilot has been shot down by enemy action after several combat missions.

Total Ground force treated with 200 mg. hrs. or more, and with at least 4 months follow up in the winter 59
Otitis media recurrent non-suppurative 40
Mixed deafnesses (Otosclerosis 3 - nerve deafness 9) 12
Recurrent suppurative 7
Free from otitis 35 or [illegible]
Chronic suppurative, cases improved 3 or [illegible]
Improved in hearing without recurrence of deafness, 15 to 40 db average for the speech range, for 4 months 40 or [illegible]
Mixed deafness, improved in hearing, 15 to 20 db for low notes 3 or [illegible]
Improvement in tinnitus 3 or [illegible]

(13)-Sheet 7

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(13) -Sheet 8 of 8

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Examination of American soldiers in England reveals that they are even more prone to develop pharyngeal lymphoid hyperplasia, secondary eustachian salpingitis and consequent otitis media on this island than in the United States. Whether this is due to climate, or living condition, or something else, is difficult to say. A very high percentage of flying personnel come to hospitals with a history of recurrent acute catarrhal otitis media. In one General Hospital, 20% of ground personnel and 35% of flying personnel had a history of recent otitis when examined. Nearly all of them had sufficient excess lymphoid tissue around their eustachian tubes to account for this.

Since Crowe and Hayler's article (1) on the prevention of deafness in childhood using radon in the nasopharynx, the John Hopkins work has been repeated in New York (2) as well as several other cities (3) (4). It seemed reasonable to try radiation on soldiers, because their otitis occurred with excess lymphoid tissue which resembled that seen in children with the same condition. The use of radon appeared particularly applicable to airmen, because interference with normal tube function, by even a small amount of swollen tissue, is likely to cause trouble when they change altitude.

Through the auspices of Professor Barclay of Oxford, contact was made with Professor Sidney Russ of the Middlesex Hospital, who arranged for the delivery of radon at regular intervals, from the Central Radium Institute Barton-in-the-Clay, Berks. Treatments were begun in December 1943 and up to March 1944, 220 patients had been treated. The most convenient dose for the laboratory to ship and to put into the capsules provided was 75 millicuries per capsule. The capsules are made of platinum 0.65 mm thick and measure 3.5 mm by 15 mm. They are attached to a semi-malleable 18 gauge wire, 14 cm in length. The radon is inserted very much as is a nasopharyngoscope, the two capsules (totalling 150 millicuries on the first day) are passed along the floor of the nose and then separated by placing a small piece of rubber tubing over the insertion wires outside the nostril (Fig 1 & 2). They are left in place 25 minutes the first day. Since 150 millicuries is equivalent to 150 mg of radium element, 25 minutes gives a dosage of 66 mg. hrs. or two gram minutes; that is, approximately the dosage recommended by Crowe (1). The radon capsules as a rule lie very near any exuberant lymphoid tissue on the medial side of the torus. For convenience they are considered as a single source of emanation in estimating dosage. However, since the capsules are separated, the total effect of 66 mg. would not reach any area in the nasopharynx. The designation 66 mg.hrs. therefore slightly exaggerates the dosage that actually reaches the nasopharyngeal walls. The exact tissue dosage is not known because the applicators will necessarily lie at different distances from the tissue in different individuals so the strength of the two applicators added together and the time that they lie in the nasopharynx is used as the most reasonable and safest approximation of the dosage.

Since radon decreases one-half of its strength each 3.85 days, the time is increased every day until there is very little activity left in the radon, i.e. not over 10 days. Table I. The treatments were originally given at 6 weeks' intervals until 4 to 6 doses had been given. There was rarely any evidence of improvement until after the 3rd treatment. If a patient had a cold or an active otitis at the

time of his appointment for treatments, half the usual dosage was given, that is 50 mg. hrs. instead of 100 mg. hrs. Then if no reaction occurred, a second 50 mg. hrs. was given in 2 or 3 days. Occasionally there was increased stuffiness in the ears without objective signs following treatment, but twice in patients with active nasopharyngitis, definite acute catarrhal otitis media with fluid levels developed. Myringotomy was not needed in these cases and the fluid disappeared in a few days. When the interval between treatments was reduced to 3 weeks, there were no untoward results. This was expected, for much more extensive radiation is given to patients with neoplasm without permanent effect on normal tissue. A small series has been tried giving 100 mg. hrs. at 4 weeks' intervals, for two treatments. Sufficient follow-up has not yet been obtained on these patients for inclusion in this paper, but the method seems to be satisfactory.

Shrinkage of the nasal mucosa, warm temperature and sunny weather, which undoubtedly have helped some of the cases treated with sulfa, but most of them had been treated extensively without relief before being sent to the 2nd General Hospital. Some of our airmen went to Africa and they were quite well until they came back. Succeeding attacks were often more persistent and more often resulted in suppuration than first attacks. Sulfonamides rarely had any effect on the disease unless it was suppurative. Even when suppuration cleared there were many cases of residual catarrhal otitis following the use of sulfonamides. This seems to be particularly so if inadequate dosage was given or if the drug was not continued for a sufficiently long period, or if the adenoids were very large.

Experience with deep X-ray therapy (2) has shown that it affects lymphoid hyperplasia in the nasopharynx very much as does radium, but patients must take many more treatments. X-ray takes longer and is more difficult to apply accurately to the eustachian tube region. It is more likely to involve surrounding tissues and produce other symptoms such as a mild parotitis, erythema of the skin or dryness of the throat. Radium element on the other hand can be used if available. The 25 or 50 mgm capsules often used in gynecological practice are convenient for this work.(2).

The greatest difficulty in the army has been to get the men back by appointment for enough treatments. They feel better and they don't come until a reoccurrence of their symptoms, or they move so that they are no longer evacuated for sickness to the original hospital before the course is finished. Many have been sent back to the United States because their nasopharyngitis or sinusitis seemed to be unamenable in this theater. These are the reasons so many cases have received incomplete treatment in our hands.

In those cases who have received sufficient dosage, and who are not plagued by chronic nasopharyngitis and sinusitis there has been a gratifying percentage of successes. (Table II).

Unfortunately, many medical officers and patients expect too much from the treatment. Radiation is not a "cure for deafness." It obviously will not improve the hearing very much if scars and adhesions interfere with the movement of the ossicles. It cannot be expected to work if a chronic sinusitis repeatedly bathes the orifices of the tubes with pus and reinfects the middle ears, or if a chronic purulent otitis is present although, at times, it does seem to help even these cases. It rarely is of benefit if severe allergic rhinitis is present.

Flyers with inadequate eustachian tube linings can often get along perfectly well on the ground or even at low altitudes, but as soon as they fly high, or are subjected to rapid changes of altitude their eustachian tubes close so that they cannot be opened. This otitic barotrauma produces anything from a mild catarrhal condition in the middle ear to an acute severe otitis with or without rupture, and may even go on to an acute purulent process. None of these conditions would develop if the tubes had not malfunctioned in the first place. Most of the malfunction of the eustachian tubes is due to swollen tissue within the tube. This tissue is not always [illegible] at the orifice. In addition to lymphoid tissue, there is often swollen glands, [illegible], as well as hyper-secretion blocking the tubes. [illegible] often causes hyper-secretion in the [illegible] which bathes the tubal orifice [illegible]. [illegible] apparently reduces [illegible] activity of glands, [illegible] the edema and the [illegible] found on hyperplastic lymphoid tissue. It is probable that the radiation has a beneficial effect on the infection present as well as producing a shrinkage of the lymphoid tissue itself.

Some physicians [illegible] that adenoids are rare in adults. American soldiers after a few months in England often have so much excess lymphoid tissue that as soon as the mouth is opened it can be seen bulging from the posterior pharyngeal wall, or behind the posterior tonsillar pillars in heavy bands. It is particularly prominent following a virus pneumonia. When it can be seen on the pharyngeal wall below the soft palate, it is invariably present in the nasopharynx above. It is often difficult in the forces to obtain a smooth narrow metal tongue blade and the small well silvered mirror and good lighting necessary for proper indirect examination of the nasopharynx. Likewise, it is often difficult to obtain a good nasopharyngoscope with a wide field and upright image for a direct examination. If they are used in every case, it is surprising how many soldiers are found to have large lymphoid masses in and about the cartilaginous portions of their eustachian tubes. Out of 2307 new patients in our Ear Nose and Throat Clinic, well over 1/3 had swollen lymphoid tissue in the nasopharynx. Of these radon treatment was begun in 220. A summary of these cases is given in Table II. Other details are as follows: 24 had adenoidectomies because radon rays do not sufficiently reduce large masses of lymphoid hyperplasia in the midline in the dosage given. Of the 2307 patients, 62 have been fliers, pilots, navigators, bombardiers, gunners, etc., with recurrent otitis due to barotrauma sufficiently severe for them to be sent for special treatment. 9 of these have been sent back to the United States after one or two treatments, because in addition to otitis they had intractable nasopharyngitis or sinusitis. A few have been lost at follow-up, the remainder are still under treatment. 79% of the airmen who have had sufficient treatment are back on full flying status, (See Table II); that is, 79% of airmen who have had two or more episodes of severe difficulty clearing their ears are now quite comfortable and have not been grounded for two months or more. Most of them had aerotitis after every flight before treatment. None of the flyers had much residual deafness by the time they reached a general hospital, so that it is difficult to give a graphic picture of their improvement. However, the fact that they are now flying several times per week, without trouble, is significant. Some of them are now dive bombing in fast planes. Of the 6 men who did not return to flying, 2 were enlisted men grounded for administrative reasons, and 2 had a residual nerve type deafness sufficiently severe to keep them from passing the hearing examination necessary for return to the air. Their non-suppurative otitis media cleared, but the high tone loss did not. The chronic non-suppurative otitis did not subside completely in one case, although he was able to carry on in ground duty. One had had severe recurrent nasopharyngitis in this theater and was boarded to the United States. It is probable that he could have flown here could he have stayed after the treatments were finished.

As for the control group, ground personnel, the results are not quite so clear cut. It is difficult to be sure that some of the 75% who stopped having recurrent otitis would not have got well without treatment. It is also probable that eventually some of them will have recurrences. Almost 5 years of experience with recalcitrant upper respiratory disease and secondary otitis media treated in this and other hospitals makes one certain clinically that radiation in the treatment of chronic adenoid tissue at the lateral nasopharyngeal walls blocks the eustachian tubes. There is also no question that if only cases without [illegible] were treated because these diagnoses are very difficult to make and essentially [illegible] the obtained even when these conditions were present. This is believed to be due to the [illegible] of a superimposed tubal catarrh. In spite of the fact that no [illegible] have occurred with the relatively safe dosage used, it is believed unwise and dangerous for an otolaryngologist to attempt radiotherapy of the nasopharynx without the continual guidance of a qualified radiotherapist. On the other hand, where such control is available, treatment of the lymphoid tissue about the eustachian tube with radon or radium is simple, relatively inexpensive and easily learned. It is infinitely more efficacious and permanent than catheterization, paliseration or hygiene. These should be reserved for the few cases in which they are indicated. (Author's). Centers for the more extensive utilization of the radiation treatment for lymphoid hyperplasia in the nasopharynx should be set up.

A report is made at this time because experience with ground personnel and children has shown that lymphoid hyperplasia in the nasopharynx predisposes to otitis media which can be controlled with radiation. A limited experience of flying personnel shows, as might be expected, that this modality also tends to prevent recurrent otitis due to barotrauma (aerotitis) when it is due to swollen tissue in and about the eustachian tubes. In practice it has put men who had been previously grounded back in the air able to fight. We need them there NOW!

The author was assisted in the examination and treatment of these patients by Captain Paul M. Cannon, U.S. Medical Corps, and in the details of radiotherapy by Lt. Col. Robert P. Hall, Chief of the Radiology Service, 2nd General Hospital. To these men acknowledgment and thanks are hereby rendered.

TABLE I

		66 mg. hrs.	100 mg.hrs.
June 1	10 a.m.	26	39
1st day	4 p.m.	27	42
June	10 a.m.	31	47
2nd day	4 p.m.	33	51
June 3	10 a.m.	38	58
3rd day	4 p.m.	40	62
June 4	10 a.m.	45	68
4th day	4 p.m.	48	74

TABLE I, showing increase in dosage time necessary each day with applicators containing 150 millicuries of radon, on the first day. Such a table is made up each time the radon is delivered so that proper dosage for each date is available without calculation.

TABLE II - Summary of Results

Total Airmen wit recurrent otitis media treated with 200 mg. hrs. or more and on whom follow up is complete. (All of these cases were aerotitis except 3)	29	
Number back flying	23	- 79%
Total free of otitis	28	- 96%
*Onepilot has been shot down by enemy action after several combat missions		
Total Ground forces treated with 200 mg.hrs or more, and with at least 4 months follow up in the winter	59	
Otitis media recurrent non-suppurative	40	
Recurrent suppurative	7	
Mixed deafnesses (Otosclerosis 3 - nerve deafness 9)	12	
Free from otitis	35 of 47	- 75%
Chronic suppurative, cases improved	3 of 7	- 41%
Improved in hearing without recurrence of deafness, 15 to 40 db average for the speech range, for 4 months	40 of 54	- 74%
Mixed deafness, improved in hearing, 15 to 20 db for low notes	3 of 12	- 25%
Improvement in tinnitus	3 of 7	- 41%

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