Urinary Cases in Other Departments.

1914. M. J., aged 54. Twenty-five years in works. Had urinary trouble, and was sent to Ancoats Hospital and later to the Radium Institute. He died, and at necropsy was found to have had a malignant growth of the prostate.

1926-27. K., aged 56. Twenty years' service: metaphenylenediamine, di-nitro-toluol, benzidine. Had neoplasm of the bladder, and died in 1927. H. was employed at the same place, and same service. He also had neoplasm of the bladder and calculus. He died in 1926. W. had the same twenty years' service as K. Was in hospital for five weeks in 1919 with acute benzidine toxæmia. Died in 1927 with growth of the bladder.

1927. W. T. was engaged for nearly thirty years in the same service as the last three cases. He complained of pain, and blood was present in the urine. He was admitted to Crumpsall Infirmary, and died. Post-mortem examination disclosed lymphosarcoma of the abdomen invading the bladder. N., aged 56, had nearly thirty years' service; at first for some years in the warehouse at the works. He was for ten years on the sulphuric acid plant; later on metaphenylenediamine. For the last ten years he was weighing barrels of finished dyes. At necropsy he was found to have extensive growth of the bladder.

1924. W. and D., young men of 25 to 30 years of age, of short service; employed in grinding diphenylguanidine. They had serious urinary pain, but no hæmorrhages. They left the works, and their further history is not known.

1924. R. J., aged 42, was employed in the works for five years. He died in Crescent Road Hospital with malignant growth of the bladder. S. was employed for many years in drying finished dyes in stoves, mainly of triphenylmethane type. He had dysuria and blood in urine in 1925. Was operated on for papilloma at the Royal Infirmary. He is still living, but not at work.

1926-27. W., a big, 16 st. man of 30. Was employed on naphthalene intermediates—sulphonations, nitrations, and reductions. Had pain, and blood was present in the urine. He was seen and treated

by Mr. Macalpine. No neoplasm was found. He is now working as a mechanic, and is well.

1927. A. had dysuria and blood in urine. He was working on cyanide crushing; no connexion established. He is quite well.

1928. T., aged 60, has had fifteen years' service on azo colours. He had blood in the urine and was treated by his own doctor. He is well and still at work.

The urines of several of the above employees were analysed, but yielded no evidence of toxic bodies.

Non-urinary Cases.

1920. Incog.; employed on various products; had carcinoma of the cæcum.

1924. R. H. was employed on various products—intermediates and triphenylmethane; also, prior to this engagement, for many years on phenol distillation. He had carcinoma of the pylorus and died.

1927. K. C. suffered from epithelioma of the scrotum, said to be due to Na₂S₂O₅ deposits in abdomen. He died.

Owing to the fact that many of the men previously had worked on processes other than α -naphthylamine, and some never on α -naphthylamine at any time, it is, in my opinion, impossible to assume this to be the most potent agent. If it were possible to have men under medical observation for a long period of years in works solely concerned with the making of α -naphthylamine, and not near any contaminating plant, and a staff of men with no previous chemical history, we might be able to trace the irritant. So far we cannot arrive at any true percentage of cases in general, owing to the following facts: (a) men sometimes employed on one job, then on another; (b) irregular operation of the plant owing to trade; (c) no proper history of men after leaving the works.

THE EFFECT OF RADIATION ON THE RESISTANCE OF RABBITS TO INFECTION WITH VIRULENT STAPHYLOCOCCI

BY

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INTRODUCTION.

THE clinical study of disease treated by general light baths suggests that the absorption of rays of light by the skin increases the general resistance of the body to bacterial infection. The curative action of light has been successful not only in surgical tuberculosis, but in certain bacterial diseases of the eye, mucous membrane, and skin. Recent research on the action of light in the cure and prevention of rickets has proved that this disease is due to deficiency of vitamin D, and that irradiation causes the production of vitamin D from ergosterol in the skin and the absorption of this vitamin. Up to the present the experimental work on the effect of irradiation on resistance to infection has been limited and contradictory. Rhode¹ found that irradiated guinea-pigs were less susceptible to inoculation of saline emulsion of tuberculous sputum than control animals. These experiments were repeated by Hase,¹ but his results were negative. Mayer² carried out a similar series of experiments, and infected guinea-pigs by inhalation; his results indicated a possible increase in resistance when irradiation preceded infection. C. M. Hill and Janet H. Clarke³ tested the effect of ultra-violet radiation on the resistance of rats to a culture of pneumococci; their conclusions signify some possible benefit if irradiation precedes infection. In their experiments shaved rats were exposed to a quartz mercury vapour lamp; the skin of some of the animals was severely burned, and this suggests that the results of their experiments may be associated with the effects of local necrosis or inflammation. Animal experiments of this nature are difficult, for it is impossible to study the effects of repeated applications of short ultra-violet rays on small areas of skin unless the hair is shaved or removed by a depilatory. This would mean that such animals would have to be almost completely shaved if the principles of "short-ray therapy" were correctly adopted.

The "minimal erythema dose" of ultra-violet rays applied to an area of skin equivalent to 20 to 30 sq. cm. per kilogram of weight increases the bactericidal power of

samples of defibrinated blood, collected one to two and a half hours following irradiation, and tested *in vitro* by the "slide cell technique" of Wright, Colebrook, and Storer.⁴ Colebrook suggests that this effect is due to increased function of the leucocytes. My own experiments⁵ on living animals suggest that following irradiation of the surface layers of the skin a photo-biochemical reaction occurs, and a bactericidal substance is first produced locally at the site of irradiation and is carried by the blood stream into the general circulation. So far experiments have failed to demonstrate bactericidal activity in extracts of irradiated skin or other tissue cell emulsions—that is, liver, spleen, testes, brain, and thymus. When defibrinated blood is directly irradiated, the bactericidal properties are diminished and the leucocytes are damaged. The intravenous injection into the living animal of irradiated blood cells and other tissue cells (testes, liver, thymus) is followed by an increase in the bactericidal power of the blood as tested *in vitro*.

The correlation of the bactericidal power of the blood so tested with the resistance to infection is so far indefinite. While some of the tests on human blood show a high bactericidal effect during acute pyrexial infections, a low hæmo-bactericidal power and an impaired efficiency of the leucocytes must be regarded as giving an unfavourable prognosis. The effects of irradiation and of many chemotherapeutic substances are only of a transient nature; it has not been possible to discover an innocuous therapeutic agent which can produce a high hæmo-bactericidal action for a prolonged period. The majority of the bactericidal compounds rapidly disappear from the blood stream and are quickly excreted; others are less soluble, are retained within the tissues, and are slowly eliminated. There is no suitable "in vitro technique" to estimate the resistance of the fixed cell or tissue immunity, and this increases the difficulties of assessment of resistance by experimental methods.

P. Hartley⁶ has shown that the exposure of immunized animals to ultra-violet rays is without effect on the content of diphtheria antitoxin or typhoid agglutinins of their serums. The conclusion which can be drawn is that the biologically active ultra-violet rays shorter than 3,100 A.U. appear to have some power to increase the "non-specific" immunity of the blood cells, but not the specific immunity. M. Hardy⁷ has summarized the effects of measured amounts of ultra-violet rays on the blood cell count of animals. The conclusions from her observations agree with those of Traugott,⁸ Aschenheim and Meyer,⁹ Cramer,¹⁰

Laurens and Sooy,¹¹ Gunn,¹² and Sooy and Morse,¹³ who all showed that irradiation of the skin increased the numbers of blood platelets, especially if they were abnormally low. Successive small doses of light had no effect on the total white count, but intensive irradiation between 3,000 and 2,750 A.U. increased the number of polymorphonuclear cells. Other observers have reported a leucocytosis and a relative increase of lymphocytes.

In conclusion, the observations obtained by experimental methods which support the theory that irradiation can increase the body resistance against infection are summarized below:

1. Antibody production may be increased by heat effects due to the absorption of infra-red and luminous rays.
2. The haemo-bactericidal power is increased by the action of ultra-violet rays from 3,100 A.U. on the skin.
3. Bactericidal substances may be formed by photo-biochemical reactions.
4. The erythema reaction causes changes in the capillary circulation and causes an intradermal polymorphonuclear leucocytosis.
5. Prolonged radiation causes an increase in total number of blood platelets and white cells, and a possible relative lymphocytosis.
6. Radiation may influence the function of the endocrine system, as shown by the effect on the suprarenal and thyroid glands.

SCHEME OF EXPERIMENTS.

During the past four years the bactericidal power of the blood has been tested *in vitro* against a stock culture of staphylococci. It has been found that one to two hours after the application of an erythema dose of rays shorter than 3,100 A.U. the haemo-bactericidal power tested *in vitro* was temporarily increased. These results have been accepted by some as evidence suggesting that irradiation of the skin increases the resistance against infection. Conversely the significance of these results has been disputed by others, who maintain that effects of irradiation are due only to erythema and counter-irritation of the skin, and the test of the haemo-bactericidal power is no index for increased resistance or immunity.

I have therefore planned a series of experiments to study the effects of irradiation on the resistance of living animals to infection. To avoid the controversy of the erythema reaction produced by short ultra-violet rays, a source of light was used by which the short ultra-violet rays were emitted and radiation to infra-red, luminous, and ultra-violet rays up to 2,850 A.U. could be applied for a prolonged period without the production of skin reactions. This method is similar to solar irradiation. Animals were infected by an intravenous injection of the same stock broth culture of staphylococci as was used in the haemo-bactericidal tests. An intravenous injection of 0.6 c.cm. of this culture was found to be constantly lethal to normal rabbits weighing about 2 kilograms.

Three groups of experiments were performed, and in each series of experiments a suitable number of normal rabbits were infected and kept in the dark, so that control observations could be made as to the virulence of infection. The series of experiments described are:

GROUP A: The effects of radiation before infection.

GROUP B: The effects of radiation directly after infection.

GROUP C: The effects of radiation before and directly after infection.

Method.

Young rabbits each weighing 1,500 to 2,200 grams were selected. Each experiment was carried out with groups of four or six treated animals, and two control untreated animals. In some cases the hair of the back was removed by means of a depilatory (calcium sulphide) one or two days previous to irradiation. These animals were carefully weighed before infection. All animals were fed on a daily diet of oats and water, and a green vegetable once or twice a week.

Technique of Irradiation.

Each rabbit was kept in a wide-meshed wire cage. Irradiation was carried out in a special treatment cubicle. The source of light employed was my new daylight lamp, which has already been fully described.¹⁴ The spectro-photographic examination showed that infra-red, visible, and ultra-violet rays up to 2,850 A.U. were transmitted.

The relative intensity of visible and long ultra-violet rays was high, and in this respect the source of light was more comparable with solar radiation than other artificial sources of light. With the normal white skin it was possible to produce erythema, but only after many hours' exposure. At a distance of 30 inches a standard culture of infusoria was killed in 120 minutes; a surface culture of staphylococci was killed in 150 minutes. The acetone methylene-blue gauge was bleached from 9 to 7.5 units after twenty-four hours' exposure. The lamp was placed in a horizontal position. All animals were exposed at a distance of 4 feet. A small motor fan was kept running in the cubicle to control the possibility of overheating; the temperature was kept at 20 to 22° C. The rectal temperatures of the animals were observed during irradiation. With this source of light prolonged exposures of forty-eight hours could be applied without the dangers of the production of severe erythema, oedema, or necrosis of the skin. In a general way this was similar to solar radiation.

Cultures and Technique of Infection.

The culture of staphylococcus employed in these experiments was a stock culture which had been periodically "passaged" through rabbits and was found to retain its virulence. Subcultures were made from the stock culture by adding 50 c.mm. to 5 c.cm. of Hartley's broth; fourteen to sixteen hour cultures were always used. Rabbits were infected by 0.6 c.cm. of a broth subculture injected intravenously into the lateral vein of the left ear.

RESULTS OF EXPERIMENTS.

Control Animals.

Total number of normal rabbits infected intravenously with 0.6 c.cm. of broth culture of staphylococci	22
Total number which died	22
Average length of time alive	under 24 hrs.
Average weight (grams) of control animals	2,054

Grouping together the control experiments, 22 normal rabbits were given an intravenous injection of 0.6 c.cm. of broth culture of staphylococci. All these animals died within twenty-four hours. Before death the rabbits were in a state of coma, breathing rapidly, and showed a rectal temperature of 106-107° F.

Post-mortem examination invariably showed acute pericarditis with 1 to 2 c.cm. of serous or sero-purulent fluid in the pericardial cavity. Heart blood cultures were positive, and grew abundant colonies of staphylococci. Occasionally a haemorrhagic congestion or oedema of the lungs was seen. Death was due to acute septicaemia.

GROUP A.—Irradiated before Infection.

Total number of rabbits irradiated and later infected intravenously with 0.6 c.cm. of broth culture of staphylococci	30
Total number which ultimately died	26
Total number alive	4
Average number of days alive (lethal time)—from 26 animals	7.43
Average weight (grams)	1,844.3

All these animals lived longer than the controls, which were not irradiated. Of 22 animals which were irradiated for 48 hours:

The number which lived for only 24 to 48 hours...	6
The number which lived for 3 to 7 days	5
The number which lived for 8 to 14 days	5
The number which lived longer than 14 days	6

Two of the latter have lived over 60 days, and the remaining four are still alive.

Eight rabbits were exposed for short periods—that is, two to twelve hours. Two of these animals were only exposed for two hours, and died within twenty-four hours. Of the remaining six rabbits:

Number which lived for 24 to 48 hours	2
Number which lived for 3 to 7 days	2
Number which lived for 8 to 14 days	1
Number which lived longer than 14 days	1

Post-mortem Examination.—The irradiated animals which died within twenty-four to forty-eight hours showed pericarditis with serous effusion, broncho-pneumonia, a positive blood culture, and death from septicaemia; some of these animals had petechial haemorrhages of the bowel. Rabbits which died after three to fourteen days had a dilated heart and myocarditis; multiple pyaemic abscesses were present in the myocardium varying in size from less than a millimetre in

diameter to 4 mm. Serous effusion, empyema, and purulent effusions were seen in the pleural cavity, with collapse of the lung, abscess formation, or purulent broncho-pneumonia. Multiple abscesses of both kidneys were frequent. Death was due to pyaemia, and the heart blood cultures were mostly positive. Rabbits which died after fourteen days showed myocardial failure; the heart was very dilated, and showed degeneration of the muscle due to myocarditis; fluid was present in the pleural and peritoneal cavities; the liver and kidneys showed changes typical of a failing circulation. The heart blood cultures of these cases were negative.

Estimation of Haemo-bactericidal Power.—Samples of defibrinated blood were collected before, during, and at the end of irradiation, and the bactericidal power against the broth cultures of staphylococci was determined. The average results from these tests indicate that the haemo-bactericidal power became slightly higher during irradiation than it was in the same animals before they were irradiated, and also higher than in control animals. This increase in haemo-bactericidal power is not as great as the results which have been obtained by irradiation with the short erythema-producing ultra-violet rays. It may be noted that the results of the tests of haemo-bactericidal power expressed in terms of the percentage average of colonies of microbes which were killed was only increased 8.5 per cent. at the end of forty-eight hours' irradiation. This was the period when many of the irradiated animals were infected.

Estimation of the Total Number of Corpuscles.—Blood counts were carried out in normal and irradiated animals. The total number of red blood corpuscles per cubic millimetre was not greatly changed, but prolonged irradiation increased the total number of leucocytes. Differential blood counts showed no change, and the relative lymphocytosis could not be confirmed.

Rectal Temperatures.—Prolonged radiation by the technique which has been described did not alter the rectal temperatures of rabbits to any marked degree.

GROUP B.—Irradiation Directly After Infection.

Total number of rabbits irradiated directly after intravenous infection with 0.6 c.cm. of broth culture of staphylococci	11
Total number of animals which died	10
Number still alive (56 days)	1
Average number of days alive after infection	2.9
Number of animals which lived 24 to 48 hours after infection	9
Number of animals which lived longer than 14 days after infection	2
Average weight (grams) of rabbits used in Group B experiments	2,127.2

These animals were injected with 0.6 c.cm. of a fifteen-hour broth culture of staphylococci, and were irradiated immediately after, irradiation being continued till death or for forty-eight hours. The shaved animals responded better than unshaved rabbits. Except for two animals which survived for seventeen and over fifty-six days, the irradiation had no marked effect, for the remainder died within forty-eight hours. Post-mortem examination showed acute pericarditis with serous effusion and haemorrhagic oedema of the lungs; heart blood cultures were positive. In all the experiments the rabbits were very ill during the first twenty-four hours following inoculation, and the rectal temperature was 105° F. to 107° F. During this acute pyrexial stage exposure to light was harmful; this view is supported by similar experiments on infected albino rabbits, all of which died rapidly when exposed to light.

GROUP C.—Irradiation Before and Directly After Infection.

Total number of rabbits irradiated before and directly after intravenous infection with 0.6 c.cm. of broth culture of staphylococci	12
Total number which died	11
Total number alive	1
Average number of days alive after infection	2.1
Number of animals which only lived 24 to 48 hours	10
Number of animals which lived longer than 14 days	2
Average weight (grams) of rabbits used in Group C experiments	1,612.5

These animals were exposed to the daylight lamp for forty-eight hours. They were then each given an intravenous injection of 0.6 c.cm. of a fifteen-hour broth culture of staphylococci, and were irradiated immediately after, irradiation being continued till death or for forty-eight hours. Except for two shaved rabbits which lived for thirteen days and over thirty-five days (still alive), these animals did not show any marked increase of resistance compared with controls kept in the dark or the Group B experiments. Irradiation during the acute pyrexial stage of illness not only failed to have any beneficial action, but antagonized the good effect of previous irradiation.

COMMENT.

It is difficult to assess the effects of radiation by clinical methods, for the variation of factors cannot establish the absolute figures necessary for statistical data. The general impression which has been recorded supports the view that irradiation increases the resistance against infection and improves the general health. In many cases this impression has been entirely based upon subjective data. Maughan and Smiley,¹³ working with students at the Cornell University, have shown that the frequency of colds in "cold susceptible" students was reduced 40.3 per cent. by weekly exposure to moderate irradiation from a mercury vapour lamp. In the experiments which have been described prolonged irradiation of rabbits increased their resistance, inasmuch as a rapid infection by an acute and virulent staphylococcus was checked, and a subacute or chronic pyaemic infection slowly progressed. The irradiated animals showed a lethal time average of 7.43 days. Although the average weight of the control rabbits was higher than the average weight of the irradiated animals (Group A), these animals all died within twenty-four hours. There was no marked erythema or skin reaction following prolonged irradiation, so that the results in this series cannot be attributed to counter-irritation or local inflammation. The observations from experiments carried out *in vitro* indicate that an increased haemo-bactericidal power and an increased leucocytosis occur during irradiation. The bactericidal effect was not as big as the results which have been previously obtained one to two hours after irradiation of the rabbit's skin with an erythema dose of rays from a quartz mercury vapour lamp. At present it is impossible definitely to associate the results of haemo-bactericidal tests *in vitro* with resistance to infection *in vivo*. These experiments prove that the intensity of infection was arrested, for although the rabbits in Group A were unwell for twenty-four hours after infection, some made a progressive recovery, while the remainder steadily lost weight and died after three to eleven days of pyaemia. During the stage of infection, irradiation was not sufficient to withstand the rapid and acute bacterial invasion. It is possible that the absorption of infra-red and luminous rays increased the pyrexial state and accelerated death, for the onset of exhaustion, dyspnoea, and coma was more rapid with unshaved infected rabbits. It would be of interest in the future to repeat these experiments with a slowly progressive infection and also to observe the results by short ultra-violet radiation.

Green and Mellanby¹⁴ have suggested that animals deficient of vitamin A are more susceptible to pyaemic infection, and their recent experiments on the treatment of puerperal septicaemia by radiostoleum support their theory. It is known that vitamin D can be produced by irradiation of the skin, and it has been suggested that the activation of this vitamin by irradiation may influence resistance to infection. As a control experiment I have recently given six rabbits a daily dose of 1.0 c.cm. of radiostoleum (which contains both vitamin A and D) by mouth for twelve successive days; after this period the animals and two control untreated rabbits of similar weight were given an intravenous injection of 0.6 c.cm. of the same broth culture of staphylococcus as was used in the experiments on irradiation. All eight animals have died within twenty-four hours from acute septicaemia. This indicates that the nature of the protection given by irradiation in these experiments was not due to either of these vitamins.

SUMMARY.

1. Previous prolonged irradiation of rabbits with a "daylight lamp" emitting infra-red, luminous, and ultra-violet rays up to 2,850 A.U. increases their resistance against virulent infection with staphylococci.

2. Experiments *in vitro* show that after forty-eight hours' irradiation the haemo-bactericidal power is increased and a general leucocytosis is produced. There is not, however, sufficient evidence to correlate these results with the increased resistance to infection. In the case of the haemo-bactericidal power as measured *in vitro*, the evidence obtained indicates that a high bactericidal power of the blood was not maintained during this method of prolonged irradiation.

3. Irradiation of rabbits with an identical technique, after infection with virulent staphylococcus, gives no protection.

4. Experiments indicate that the results are not due to the production of vitamins (A or D).

This research was carried out in Professor Leonard Hill's laboratory at the National Institute for Medical Research, Hampstead. I am greatly indebted for his kindness, constant advice, and help during the progress of these experiments.

REFERENCES.

- ¹ Rhode and Hase: Quoted from E. Mayer and M. Dworski, *Amer. Rev. Tuberc.*, vol. 10, 1924, p. 157.
- ² Mayer, E.: *Amer. Rev. Tuberc.*, vol. 10, 1924, p. 157.
- ³ Hill, C. M., and Clarke, J. H.: *Amer. Journ. of Hygiene*, vol. 7, No. 4, July, 1927, pp. 448-463.
- ⁴ Wright, A. E., Colebrook, L., and Storer, E. J.: *Lancet*, 1923, i, 365, 417, 473.
- ⁵ Eidinow, A.: *Lancet*, November 5th, 1927, p. 963.
- ⁶ Hartley, P.: *Brit. Journ. Exper. Path.*, vol. 5, 1924, p. 306.
- ⁷ Hardy, M.: *Amer. Journ. of Hygiene*, vol. 7, No. 6, November, 1927, pp. 811-837.
- ⁸ Tranggott, K.: *Munch. med. Woch.*, i, 17, 1920, p. 344.
- ⁹ Aschenheim, E., and Meyer, S.: *Zeit. f. Exper. Path. u. Ther.*, 22, No. 22, 1921.
- ¹⁰ Cramer, W., and Drew, A. H.: *Brit. Journ. Exper. Path.*, vol. 4, 1923, p. 271.
- ¹¹ Laurens, H., and Sooy, J. W., *Proc. Soc. Exper. Biol. and Med.*, 22, 1924, p. 114.
- ¹² Gunn, F. D.: *Proc. Soc. Exper. Biol. and Med.*, 24, 1926, p. 120.
- ¹³ Sooy, J. W., and Morse, T. S.: *Journ. Amer. Med. Assoc.*, 87, 1926, p. 94.
- ¹⁴ Eidinow, A.: *British Medical Journal*, April 13th, 1929, p. 680.
- ¹⁵ Maughan, G. H., and Smiley, D. F.: *Journ. of Preventive Med.*, 2, 1928, p. 69.
- ¹⁶ Green, H. N., and Mellanby, E.: *British Medical Journal*, October 20th, 1928, p. 691.

THE RELATION OF EAR CONDITIONS TO BATHING.

BY

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As the bathing season is now at its height, it does not seem out of place to set down some of the dangers which are liable to beset the community at this time of year. The daily papers are taking an increasing interest in the health of the populace, yet insufficient attention has been drawn to the precautions necessary for those who wish to avoid the inconveniences which may result from careless indulgence in swimming. Many medical men allow their patients too much licence in this direction, and fail to pay attention to small details which would increase the comfort of all.

It is obvious to those who attend out-patients in any large ear, nose, and throat clinic that a great number of acute aural conditions develop as the result of bathing. Moreover, such conditions may have dangerous sequels. For a long time at King's College Hospital we have had a notice placed in the out-patients' department which warns patients against bathing without leave from the surgeon.

From the point of view of the ear, nose, and throat surgeon the bathing community can be divided into (1) healthy persons; (2) those with septic nasal conditions (including the common cold); (3) those with a perforation of the tympanic membrane; (4) those with recurrent dermatitis or furunculosis of the external auditory meatus.

As regards persons in normal health, the public has a vague idea that water introduced into the meatus may be dangerous, and cotton-wool and other substances are used to prevent this. In such persons the entry of water does no harm, though it may give rise to several unpleasant symptoms. Among these are deafness and tinnitus following immersion. This is due to the swelling of wax and occlusion of the meatus, or to water collecting behind an accumulation of wax, where it may remain for some time. Another cause is the foolish practice of drying the ears with the rolled-up corner of a towel, thus pressing down against the drum any wax that may be in the meatus. Some may complain of a transitory earache due to cold water impinging on the drum, but this symptom should not be "passed off" without thorough examination lest acute otitis media be the cause. We have not yet met a case of vertigo; in fact, this is hardly to be expected, as

cold water enters each meatus with equal caloric stimulus to both labyrinths, so that the labyrinthine equilibrium remains undisturbed. The possibility of the occurrence of such a symptom must, however, not be overlooked, for it could occur if one meatus was occluded and the other patent.

Too often acute otitis media, with or without dangerous complications, occurs in the healthy swimmer. This is due to the entrance of infected water into the Eustachian tube and middle-ear tract. Public swimming baths and "town" rivers are great sources of danger. Those who bathe in the sea or in mountain streams are usually exempt from trouble. The healthy Englishman is fond of swimming, and in the large towns public baths afford the only facility. There is therefore a crying need for those in authority to render the public baths as safe as possible. It is essential that constant inspections should be undertaken. The problem is a difficult one, for disinfectants cannot be introduced in sufficient concentration without rendering bathing irksome. Calcium chloride is used in many places; it imparts a somewhat unpleasant taste to the water, and usually gives rise to a mild conjunctivitis. Naturally water is not rendered safe by this means, but if continuous filtration is carried out as well the risk is minimized. It is interesting to note that we have not been able to trace more than an isolated case of ear trouble attributable to bathing in the Camberwell baths, where this method is practised. In far too great a proportion of public baths the water is not changed often enough, whilst scouring of the empty bath is inefficiently carried out. It should be made compulsory for bathers to wash with soap before entering; in Germany this is an almost universal practice. Again, it is a bad principle that bathers should be allowed to come in straight from the streets and tramp along the sides of the bath in their grimed boots. All this filth must sooner or later find its way into the water.

The present facilities for bathing will not be revolutionized for some time, so we must consider what type of swimmer tends to develop acute otitis media and how the risk may be minimized. As a rule it is the badly taught, inexperienced swimmer who suffers most and becomes the victim of an "acute ear." Correct breathing is essential to prevent the entry of infected water into the Eustachian tubes, and it is here that the tyro fails. The practised swimmer fills his lungs at regular intervals through the widely opened mouth, keeping the soft palate raised and thus shutting off the nasopharynx. In fact, many swimmers of repute continually have the mouth open, even under water, gradually blowing air out until they need a fresh inspiration, when the head is turned clear of the water and air taken in through the mouth. The inexperienced swimmer fails to regulate his breathing properly, draws the water into his nose, chokes, and swallows; this last action opens up the Eustachian tubes and water is allowed to enter. For the same reason it is unwise to "duck" suddenly or to push a friend in unawares; proper inspiration is difficult in such crises. Jumping in from a high board should not be practised without holding the nose, as the sudden inrush of water into the nostrils may force some into the sinuses or into the Eustachian tubes.

It will be argued that thousands of people in normal health bathe regularly without precautions and come to no harm; nevertheless, the risk is there, and correct breathing should be taught.

The second class, those suffering from septic nasal conditions (including the common cold), should not be allowed in public baths. Not only do they spread infection, but any water entering the nose may carry infection backwards into the nasal accessory sinuses or Eustachian tubes. Swimming is dangerous in the same way as the pernicious habit of sniffing salt and water up the nose to relieve the common cold.

Patients who have a perforated tympanic membrane often ask whether bathing is permissible. Whether or not there is discharge the answer should be an emphatic "No." Those in whom the discharge has ceased will almost certainly become reinfected, with consequent exacerbation of old trouble; whereas those with an active discharge will contaminate the water and lay themselves