INFRA-RED RAYS, COMFORT, AND HEALTH

BY

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While they enjoy a bright open fire some people dislike dull red gas or electric fires, stoves, and hot-water pipes, and usually suppose that such sources are unpleasant because they dry the air, or give off fumes: they are supported in this opinion by the relief felt on opening a window. These people also feel uncomfortable in a crowded room, and put their discomfort down to pollution of the air by respiration. Scientific investigation has, however, proved that in such crowded rooms there is no physiologically significant alteration of chemical purity, and that the cooling power of the air is really the important factor. Yaglou¹ and his co-workers have shown that ions diminish in number in the air of a crowded room, but no relation has been established between alterations of ionization of the air and comfort. While some people are very sensitive others are indifferent to the type of heater used in a room, or to the room's crowded state. In the House of Commons some members complain greatly of the system of heating and ventilating used there; others say that it is very good. Then again, there are some people who like open windows and others who call these ones "open-air fiends." When the katha-thermometer was introduced by me as a measure of comfortable conditions I empirically fixed a cooling power of 6 for rooms in this temperate climate. It takes a much higher cooling power—for example, 12 to 14—to increase the heat production of a man in ordinary clothing, so efficient are the means of the body for regulating heat loss. The feeling of freshness given by a moderate cooling power is not due then to any change in the rate of heat production. It is known, too, that alterations in relative humidity at ordinary room temperature from 40 to 70 per cent. have no sensible effect on comfort. Some people, however, put a bowl of water in front of a stove, and are made more comfortable by this, and yet such a bowl produces no detectable increase of humidity in the air.

CAUSE OF "STUFFINESS"

All these facts receive an explanation when it is realized that a cause of discomfort and stuffiness is the quality of the infra-red rays given off by the source of heat, and their effect on the naked parts of the skin. The feeling of dryness and unpleasant quality of heat is due to direct action of irradiation on the skin, while stuffiness is due to a reflex congestion of the nasal membrane resulting from the action of the rays on the cutaneous nerves.²

This reflex effect is pronounced in some with a deflected septum, or with a chronic catarrhal and stuffy state of the nose. It can be made evident to most of those who have widely open noses by means of a screw nose-clip adjusted to narrow the air-way until the breathing is only just adequate in cool air—for example, by an open window. Exposure of the face to a dull red or dark source of heat then makes the breathing difficult, while screening at once gives relief. Cool air from an open window or fan antagonizes the "nose-closing" effect. Hence, sensitive people with stuffy noses like the open air and an open window, and dislike shut-up rooms heated by dark or dull red sources. The less open side of the nose of a sensitive person may be sensibly obstructed by merely covering the face with the hand, or going under the bed-clothes. The immediate discomfort felt on throwing a hood over the face may in part be due to this reflex. The "nose-closing" effect is at once set aside by cooling the irradiated part of the skin, or other parts of

the body, in this case to a sensible degree. The open window in the bedroom prevents the stuffy effect, and this is one of the benefits of open-air treatment. In cool air the mucous membrane is kept taut and with a better flow of blood and secretion.

PRACTICAL APPLICATIONS

Cooling of the irradiated part of the skin by evaporation of sweat prevents the reflex. When one sits down in a warm bath the reflex comes into play until the face is wetted. A bowl of water set in front of a dull red and dark source of heat affords relief, because the vapour rising from it screens off some of the offending rays. If set to one or other side of the source it ceases to be efficacious, but it can be placed anywhere between the source and the face of a sensitive subject and exert its "nose-opening" action. A glass screen is also protective. In the case of some sensitive people the "nose-closing" effect is set aside by rays from a bright incandescent source acting either on the same or some other part of the skin. Such a source gives off more of the short infra-red rays and feels pleasanter. The makers of modern gas fires have increased the radiant power and brightness of the clay "radiants," with the result that, while the old-fashioned gas fire was a "nose-closer," the modern one is a "nose-opener." The dull red electric fire is a "nose-closer," but by increasing the current through a Ferranti bar fire from 5 to 6 amperes, and so making it brighter, the "nose-closing" effect was abolished. A very little alteration then is required to make uncomfortable dull red sources of heat more comfortable. A screen of gelatin, horn, or cellophane (acetyl cellulose) converts a bright source into a "nose-closer." A study of the transmission of infra-red rays by such screens, made by Dr. H. J. Taylor, shows that they absorb a group of infra-red rays about 30,000 A.U. These rays must be "nose-openers." Just like the physiologically active ultra-violet rays, these rays only just reach, in small intensity, the living cells of the epidermis and the nerve endings among them. The prickly sensation of heat produced on the face by contiguity with an electric fire is relieved by switching on an incandescent lamp held close to the face, and best used with addition of a glass screen. Most people then say "it feels cooler." The shorter infra-red rays, like the red rays, penetrate the skin and provoke flushing, transudation, and a moist skin. The heat resulting from their absorption is carried away by the blood. The long infra-red rays do not penetrate, and produce a dry and hotter surface. The pleasanter feeling of bright sources seems to depend on this difference. The bright sources also have more of the "nose-opening" group of rays. The standard katha-thermometer cooling power of 6, which I had empirically fixed as comfortable, is explained by the need to counteract by cool air the stuffy and unpleasant quality of dark heat rays.

EXPERIMENTAL WORK

Miss Murray, at Bedford College, has recorded the "nose-closing" reflex, the mouth being closed by a rubber gag, and the more open side of the nose plugged with cotton-wool, and has found about thirty out of sixty subjects are more or less sensitive. In a few cases the breathing is obstructed and in others is made quicker and shallower.

I have recorded the reflex effect by fitting the end of a rubber tube in one side of the nose (the best) and connecting this tube with a recording tambour. The mouth being kept closed, the changes of pressure, produced by breathing through the other side of the nose, are recorded by the tambour, which writes on a smoked drum. The effects produced on one sensitive subject, Dr. R., are

shown in the figure. I also use a mask which covers the mouth and nose. The mouth is closed, and nasal breathing takes place through an orifice in the mask, which is so restricted that step-climbing can just be comfortably carried on in a cool room. The steps are made on and off a box in time with the beats of a metronome. On allowing the rays from a dull red electric fire to fall on the face the step-climbing soon becomes impossible in a sensitive subject through want of air. On switching on a fan, or an incandescent lamp, ease in step-climbing is renewed. The experiment can be carried out with the fire put under the table so as to radiate the bare legs. The screen in front of the fire can then be withdrawn silently by an observer, while the eyes of the subject are kept shut. The eyes should not be covered by a bandage, because this in itself affects the nose of a sensitive subject.

Inhalation of a vaporized adrenaline solution abolishes the reflex "nose-closing" effect. The adrenaline con-

Tracing shows effect on nasal breathing of electric fire, fan, and incandescent lamp. (1) Exposed to electric fire; (2) opened mouth to take a breath, fan then put on, and nasal breathing resumed; (3) fan stopped; (4) incandescent lamp switched on.

stricts the blood vessels, and, preventing vascular congestion of the membrane, keeps the air-way open. The effect of the inhalation lasts for an hour or so. The sensitivity of the skin to the "nose-closing" rays in certain sensitive susceptible subjects is very great. When only one square inch of skin is exposed, and the device is put several feet away, the reflex may result. In a still room at ordinary temperature I was sensitive to the "nose-closing" rays of an electric fire when facing this at a distance of 47 feet, where, of course, no sensation of heat was felt. At a distance of 1 metre from a thermopile the energy of an incandescent lamp was found to be $1/60$ of that of an electric fire. When one square inch of skin was exposed at that distance to this fire the "bad" side of my nose became closed; when another and equal area of skin was exposed to the lamp the nose was opened. The latent time in each case was about six seconds. The latent time is much shorter when a large area of skin is exposed; the effect varied as $\sqrt{a \cdot t}$, where a = the area and t = the time. At various distances from the source the effect varies as $\sqrt{i \cdot t}$ where i = intensity and t = time.

Out of sixty-seven subjects recently tested at the London Clinic and Institute of Physical Medicine, fifteen were insensitive, while forty-two showed more or less evidence of the "nose-closing" effect. Asthmatic and catarrhal patients are likely to be more sensitive than others. In all except four of these forty-two the fan made the breathing easier, while twenty-five found it made easier by the incandescent light, and twenty-one by the water bowl.

CONCLUSION

In considering the various baths used for stimulating the skin and producing curative effects, it is of interest to have found evidence of a reflex effect of a striking character. In my case the "nose-closing" effect is accompanied by a slight rise of blood pressure. In regard to heating and ventilating rooms, it is clear that where dark sources of heat are employed there should be adequate ventilation with cool air. This is required not only to produce comfort and a feeling of freshness, but to keep the atmosphere as clean as possible from dust and microbes. Incandescent lamps make such sources pleasanter. Electric fires can be improved by making them brighter sources of heat. A sensitive subject who suffers from nasal catarrh has been improved by replacing in his room a hot-water radiator by a Ferranti bar fire which was made to take 6 amperes. Irradiated with this bright heat he works in comfort with a window open, and has better health. A modern gas fire would have done as well.

REFERENCES

- ¹ *Journ. Indust. Hyg.*, 1933, xv, 8.
- ² Hill, Leonard: *Proc. Physiol. Soc.*, November 14th, 1931, and May 14th, 1932; *Compt. rend. IIe Congrès Internat. de la Lumière*, Copenhagen, August, 1932, p. 160.

REHALATIONAL ANAESTHESIA

A METHOD OF UTILIZING THE RECENT ADVANCES
IN ANAESTHETIC ADMINISTRATION

BY

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General inhalational anaesthesia to-day is induced and maintained either by one of the modern types of apparatus or by the time-honoured open mask and drop bottle. Apparatus is of the greatest importance in the anaesthesia of modern surgery. In many operations on the head and neck, and in thoracic surgery, it is essential. It is not my object in this article to decry its use, but to try and show those who are called upon to give routine or occasional anaesthetics that, by adopting a combination of methods of administration which have been advocated from time to time, they can secure practically all the very real advantages of the more costly and complex apparatus by a technique which rivals the open mask for simplicity and economy.

The mechanization of anaesthesia is the outcome, to a great extent, of the practical application of the results of recent research, discoveries which cannot be employed when the open mask is used.

RESULTS OF RECENT RESEARCH

Haggard¹ has shown that narcosis depends upon the anaesthetic tension of the agent exhibited, which, in the case of ether, is that concentration of the vapour with which the cells of the central nervous system are in equilibrium. This equilibrium is only reached after gaseous interchanges have taken place, first between the pulmonary blood and the vapour-bearing air entering the lungs, and then between this blood and the tissues. Furthermore, owing to the high absorption quotient of lipid tissue and the volume of blood passing through the central nervous system, this concentration practically equals that of the arterial blood. Thus the rate of absorption depends solely on the amount of ether brought to the blood, and this depends on the volume of respiration. He has shown by experiment that to maintain a state of