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CURRENT PROGRESS IN STERILIZATION OF AIR

BY

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"The prevention and control of acute disease of the respiratory tract is the most serious problem and at the same time the most urgent challenge that to-day confronts medicine in general and industrial medicine in particular. Although diseases and injuries of occupational origin have long claimed the chief interest and attention of physicians in industry, it is now well established and generally recognized that in their frequency and importance non-occupational diseases far outweigh those conditions which arise from industry. The latter are chiefly responsible for stupendous losses in both time and money to employer and employee alike."

The sentences quoted opened an address by George Morris Piersol at the Third Annual Congress on Industrial Health in Jan., 1941. Does examination of available data on industrial disability due to acute respiratory disease indicate that this challenge is being met in current practice? Quite the contrary. The frequency of sickness and non-industrial injuries causing disability for 8 consecutive calendar days or longer among a very large sample of industrial workers over the years 1933-42 has been analysed by the United States Public Health Service (Gafafer, 1943a). Sickness absenteeism among males due to respiratory disease has shown a steadily mounting rate since 1938; the rate for 1942 was higher than in any previous year of the 10-year period. For females the rate has been steady since 1939, but at a high level. Moreover, respiratory sickness in male industrial workers in the first quarter of 1943 (Gafafer, 1943b) was far higher than in the corresponding quarter of 1942; indeed, the respiratory rate for the first quarter of 1943 has never been equalled or exceeded during the 10-year period, the first-quarter rate of 1943 exceeding the 10-year mean rate by 52%.

Whatever are the causes of this high and mounting rate of industrial disability due to respiratory disease, common sense cautions us not to seek the complete explanation in the conditions of work in industrial establishments alone. The packing of industrial and other workers in the ill-ventilated common carriers—trains, street cars, and buses—since rubber and petrol shortages have been overtaking already taxed transportation facilities, certainly provides one superlative opportunity for the spread of endemic and epidemic respiratory disease; crowded and confined places of amusement provide another.

In attempting to form even a rough estimate of the cost of this industrial disability, recourse may be had to smaller samples which have been subjected to more detailed analysis. Figures for a public utility for the period 1938-41, inclusive, have been published (Gafafer, 1943c); these show that days lost from respiratory disease are more than a third of the total days lost from all causes of disability. Dr. Gafafer has kindly permitted use of a similar table for 1942. This gives the average number of absences lasting one calendar day or longer in a sample comprising approximately 2,500 male and 550 female employees in a public utility in 1942. The average number of

days lost per person during 1942 owing to respiratory disease was for males 3.1, for females 4.3. It is of course understood that the figures for one company cannot be taken as representative of conditions in American industries as a whole. These rates may be either too high or too low. To gain an idea of the approximate cost, if these rates were accurately representative, however, we may multiply them by the numbers of non-agricultural workers in the United States; these are approximately 26 million male and 14 million female workers (Gafafer, personal communication). This yields an approximate total (with the reservations mentioned) of over 80 million man-days and over 60 million woman-days (or over 140 million person-days) lost to industry in the United States through respiratory disease in 1942. On the basis of 300 working days per year, this waste is approximately equivalent to the time of 470,000 persons working for a year.

The Bureau of Labor Statistics publishes monthly data on straight-time hourly earning for manufacturing industries in the United States as a whole (B.L.S. Chart Series, May, 1943). I have computed an average daily earning by multiplying the straight-time hourly earnings (80.5 cents) by 8, the normal working day in American industry.* On this basis the loss in wages due to respiratory sickness amounts to roughly \$900,000,000 per annum. This does not include the expenses for medical care, overhead expenses arising out of idle machinery, and interruption in production schedules, etc.

Relation between Respiratory Disease and Infectiousness of Air

Persons sneezing, coughing, or even speaking loudly expel into the air large numbers of minute droplets which may contain in a viable and infective state any pathogenic bacteria or viruses present in their oral secretions. The larger of these potentially infectious droplets have a flight range of about a metre; they are conspicuous, are easily recoverable on bacteriological plates, and their ability to transmit respiratory infection is obvious. When droplets or sputum have dried on solid surfaces their residues may become the source of infective dust.

The role of droplets was notably stressed by the German hygienist Flügel† (1897a, 1897b), and the doctrines of "droplet-infection" and dust-infection, or transmission of respiratory infection by droplets and by infective dust, dominated thinking in regard to respiratory disease for 30 years.

The greater part of the potentially infective material expelled by persons into the air, however, is not contained in droplets visible without special means, but in smaller droplets which

* It is unfortunate that daily rates of pay are not available. Since the figure representing costs of time lost due to respiratory disease is at best only an approximate one, the straight hourly earnings (excluding overtime earnings) are multiplied by 8 to secure a daily wage. It is recognized that this is somewhat arbitrary.

† Actually, however, Flügel himself appreciated the importance of invisible droplets accompanying the coarser visible droplets; these, he recognized, may persist in air for hours and reach distant parts of enclosed spaces.

evaporate almost instantaneously. The basic experimental demonstration was made by Wells (1933) and by Wells and Wells (1942) that much of the enormous germ-load conveyed to the atmosphere by the evaporated residues ("droplet-nuclei") of these finer droplets remains viable for hours or even days in the air of enclosed spaces and is wafted about like smoke to convey pathogenic bacteria or viruses to those who share the confined air. The atomizing of mouth-and-nose secretions into the air has lately been revealed with dramatic vividness by high-speed photography (Jennison, 1942). The enormously important role of pathogens floating in confined air in the dissemination of respiratory disease has now been adequately documented by animal experiments, by observations in controlled human environments, and by epidemiological deductions; the evidence to 1941 has been conveniently assembled in *Aerobiology*, a volume published by the American Association for the Advancement of Science with the aid of the Committee on Aerobiology of the National Research Council.

Any attempt to appraise current progress in the sterilization of air must, however, take account of the historical background. Members of the medical profession who now occupy responsible positions in practice, in teaching, and in administration have been thoroughly trained in the doctrine of "droplet-infection." Recognition of the greater importance of true air-borne infection has come only within the past 10 years, and has deeply impressed only the relatively small number of those who have seriously examined evidence which is either very modern or very old. (Of course, important foundations of the germ theory of disease were laid by the studies of Pasteur, Tyndall, and others on micro-organisms in the air.) Lack of a more insistent demand on the part of the medical profession for practical solution of the problems of air-borne infection might seem incomprehensible if this background were lost sight of. Lacking adequate demand by many prominent members of the medical profession for progress in securing pure air-supplies, air-conditioning, from the standpoint of health at least, has somewhat neglected the main point. The point is that, just as intestinal disease has in considerable measure been controlled by reducing the germ-load of water and milk, for the control of air-borne respiratory disease practical measures for reducing the germ-load of confined air must be instituted.

Continuous Disinfection of Air

Effective continuous disinfection of the air of enclosed spaces has already been shown to be practicable where conditions are favourable and where the problem is approached with adequate determination and technical facilities and skill. The practical means are physical (ultra-violet radiation, dust-suppressive measures) and chemical (germicidal vapours). Doubtless physical and chemical means will each find appropriate place as mutually complementary measures in the fully matured art of providing non-infectious air in our future homes, transport vehicles, and places of work and recreation.

Ultra-violet Radiation

Application of ultra-violet radiation to disinfection of air has been systematically reviewed in the A.A.A.S. volume on aerobiology. The physiological and germicidal effects of ultra-violet radiation and the characteristics and standardization of commercially available ultra-violet sources are surveyed in detail. The successful application of ultra-violet radiation to reduction of wound infections in the operating-room is presented by Dr. Deryl Hart, the pioneer in this field, and by Drs. Kraissl and Wilson of Columbia. Cross-infections in hospital wards and in children's nurseries and schools are reviewed and analysed, and success in the reduction of these cross-infections by appropriate use of ultra-violet irradiation is recorded. More detailed analyses of successful control of childhood contagions in schools have been published by Wells, Wells, and Wilder (1942) and by Wells and Wells (1943).

More recent records of germicidal action against bacteria and viruses by ultra-violet radiation in a children's hospital, with reduction in cross-infection, have been published by Sommer and Stokes (1942), by Henle, Sommer, and Stokes (1942), and by Robertson, Doyle, and Tisdall (1943). The Council on Physical Therapy of the American Medical Association (1942,

1943) has found ultra-violet lamps acceptable as an adjuvant in the disinfection of air, and commercially available luminaires and fixtures of several types have been approved by the Council (C.P.T. Reports, 1942, 1943a, 1943b) for use in the operating-room, hospital nursery, and hospital ward.

The statement of the Council on Physical Therapy on acceptance of ultra-violet lamps for disinfecting purposes contains carefully considered appraisal of the present status of the practical art. Pertinent statements are quoted below:

"At the present juncture the design and installation of ultra-violet lamps in their fixtures for disinfecting purposes is empirical, and the adequacy of disinfection by any given installation of lamps must be judged by clinical experience. For example, clinical evidence has been submitted to the Council showing that, in a scarlet fever ward (size about 60 by 27 by 11 ft.) containing 16 cubicles, four lamp units, each one emitting a radiant flux of 30 microwatts per sq. cm. at 1 metre, were found inadequate; but eight lamp units in the ward, each unit protecting two cubicles, and a ninth unit at the entrance, prevented cross-infection. This is a rather high intensity (requiring 20 minutes' calculated time to produce a minimum perceptible erythema) incident on a person of average height, standing directly under a lamp fixture suspended from a ceiling of average height. A greater number of lamps, each one of lower ultra-violet intensity (say, 20 microwatts per sq. cm. at 1 metre) and lower power input, more evenly distributed throughout the room, should be safer and equally efficient in disinfecting the air. This is a matter of engineering design, beyond the scope of the Council's purview. . . .

"Since the ultra-violet emission from the low-vapour-pressure mercury discharge tube is practically homogeneous radiation of wavelength 2,537 Å, such a lamp can be readily calibrated in absolute value and used as a standard. The intensity at 1 metre may be only one-fifth of the Council's unit, or 20 microwatts per sq. cm., for safety to the occupants. This will require a minimum exposure of 250 to 500 seconds for adequate disinfection, which will depend on the rate of circulation and average distance of the air in front of the lamp. Evidence has been submitted to the Council showing that cross-infection in a contagious ward may be prevented by using a sufficient number of lamp units, each unit having an intensity of 30 microwatts per sq. cm. at a distance of 1 metre from the burner. This will require an exposure of 167 to 334 seconds for adequate disinfection, which implies a slow movement of the air in front of the lamp installation. . . .

"The use of ultra-violet radiation for disinfecting air in industrial plants, barracks, school-rooms, assembly halls, refrigerators, and so on also appears to be outside the Council's purview. In fact, at this juncture the whole question of the use of ultra-violet radiation for disinfecting purposes is too complex and too little understood for the Council to do more than attempt to keep the medical profession informed regarding particular ultra-violet lamps that are acceptable for use in this method of disinfecting air in hospitals, nurseries, and operating-rooms (relatively free from dust) as practised by present-day empirical methods."

It must be emphasized that the Council's statement of acceptance does not prejudice the applicability and the usefulness of ultra-violet radiation to the problem of disinfecting the air of industrial plants, offices, assembly halls, railroad cars, etc. It emphasizes, however, that the specifications of engineering design and other features determining the adequacy and safety of the practical art must be further developed and applied before evaluation will become possible.

Another paragraph of the Council's statement discusses responsibility for design of installations.

"It is to be noted that a lamp used for disinfecting purposes is a single unit in an installation, and that compliance of the ultra-violet output of a single lamp unit with the Council's requirements does not ensure adequate radiant disinfection or the safety of the occupants of the room in which an installation of such lamps is in actual use. Obviously the manufacturer and the distributor of such lamps must assume some responsibility for the adequacy of the lamp installation for purposes of radiant disinfection of the air, and for the adequacy of the protection from injury of the occupants of the space irradiated. Concerning these questions the Council cannot undertake supervision or assume responsibility for the satisfactory performance of any particular installation."

The Senior Biophysicist of the Division of Industrial Hygiene, National Institute of Health (who also is Associate Referee for the A.P.H.A. on Disinfection of Air by Ultra-violet Irradiation), has critically reviewed applications, precautions, and limitations of the use of ultra-violet irradiation to disinfection of air (Hollaender, 1943). The statement of the Council on Physical Therapy is quoted with approval (Hollaender, 1943): "Obviously the manufacturer and the distributor of such

lamps must assume some responsibility for the adequacy of the lamp installation for purposes of radiant disinfection of the air, and for the adequacy of the protection from injury of the occupants of the space irradiated."

Acceptance by the engineering groups in whose province air hygiene may be considered as properly falling of a measure of responsibility for elaborating specifications for proper design and servicing of installations would be an important step towards development of a practical art of air hygiene.

The efficacy of ultra-violet irradiation in killing air-borne bacteria and viruses under conditions in which the air is relatively free from dust and lint has been confirmed in Great Britain by Andrewes *et al.* (1940) and by Edward, Lush, and Bourdillon (1943). The difficulty of disinfecting dust-laden air by this means has also been emphasized. Andrewes *et al.* suggest the combination of air filtration and ultra-violet irradiation in recirculation systems and for certain special purposes.

Germicidal Vapours

The spraying of germicides into the air was of course a part of the technique of antiseptic surgery. Modern interest in germicidal mists was stimulated by the demonstration by Douglas, Hill, and Smith (1928), Trillat (1938), and Masterman (1938) that certain bactericidal substances—e.g., NaOCl and a number of phenolic compounds—when dispersed in the air as fine mists or aerosols exerted a highly lethal effect on air-borne bacteria. Twort, Baker, Finn, and Powell (1940, 1942) found that hexyl-resorcinol dissolved in propylene glycol made a highly effective and satisfactory germicidal aerosol.

An inclusive and practical discussion of the problems of air-borne infection and means for its amelioration in wartime Britain has been presented by Andrewes *et al.* (1940). Concerning germicidal mists and vapours they conclude: "*Hexyl-resorcinol* in propylene glycol has proved perhaps the most effective under laboratory conditions, but unfortunately neither the antiseptic nor its solvent is at present readily enough available* in large amounts to warrant its introduction except for special purposes."

Considerations of economy and practicability as well as of efficacy have served to focus attention in Britain on the germicidal value of hypochlorites and hypochlorous acid. Actually the use of hypochlorites for purification of air was first tried in England as early as the influenza pandemic in 1918. Masterman (1941) reviews in detail the early history and various controversial aspects of the use of hypochlorites for air purification. He describes an atomizing device (dynalysor) as already in successful operation: "For many months the dynalysor has been successfully employed for hypochlorite spraying in hospitals, offices, and other inhabited rooms; and air purification by hypochlorites is not a scheme 'with definite possibilities' but a successful *fait accompli*." Masterman concludes that HOCl gas is the active germicide in hypochlorite spraying.

Bourdillon, Lidwell, and Lovelock (1942) have reported success with hypochlorite atomized by a hand spray in disinfecting air contaminated by sneezing. They note certain unfavourable conditions, "such as low relative humidity or high content of organic matter in the air, which may hinder the action of hypochlorite sprays."

Edward and Lidwell (1943) report favourable tests on sterilization of air-borne influenza virus with hypochlorous acid gas. "A concentration of 1 vol. of gas in 2 million vols. of air is probably effective in destroying 99% or more of virus particles when the proportion of these in the air is small. Preliminary experiments on mice and cats are recorded which failed to reveal any toxic effects produced by inhaling the gas in relatively high concentrations or for prolonged periods. Acute irritation of mucous membranes only was found. This did not appear to lead to any increased susceptibility of mice to subsequent infection with influenza."

Exploration of the possibilities of continuous disinfection of air by chemical substances has made and is making rapid progress in America through the work of O. H. Robertson and his associates. They determined that certain of the glycols alone, notably propylene glycol (Robertson *et al.*, 1942) and

triethylene glycol (Robertson *et al.*, 1943), provided promising means for continuous disinfection of air. They demonstrated that the germicidal action depended, not, as earlier supposed, upon collision of fluid droplets with air-borne bacteria, but upon condensation of hygroscopic glycol molecules upon air-borne droplets containing bacteria. The use of 1 g. of propylene glycol dispersed as vapour in 5 or 10 million c.cm. of air and 1 g. of triethylene glycol vapour in several hundred million c.cm. of air was found to kill pathogenic respiratory bacteria and the virus of influenza in air in seconds or minutes. Rat and monkey colonies kept constantly in atmospheres saturated with vapours of propylene glycol for periods up to 18 months and triethylene glycol up to a year suffered no ill effects detectable by observation or microscopical examination (Robertson, 1943b).

"The germicidal activity of glycol vapours is markedly influenced by certain environmental factors, the most important of which is atmospheric humidity (Robertson, 1943b). A dry atmosphere is unfavourable. Likewise desiccated bacterial particles are not as susceptible to the vapour action as are moist ones. It has been found that the glycols are most effective at relative humidities between 40 and 60%." Subsequent work by Bigg, Jennings, and Fried (1944a) and Bigg and Jennings (1944) places the relative humidity for maximal germicidal action of glycol vapours at from 30 to 50%. The former workers indicate also the types of apparatus that are being developed for disinfection of the air of large enclosed places by glycol vapours.

Careful investigation of the possibility of fire hazard resulting from the dispersal of glycol vapours into the atmosphere of enclosed spaces has also been made by Bigg, Jennings, and Fried (1944b). These authors conclude: "In the vapour-phase concentration required for air sterilization, propylene and triethylene glycol offer absolutely no fire or explosive hazard. The addition of water to these substances greatly reduces the possible fire hazard produced by their presence in storage or vaporizing devices."

Clinical application of glycol vapours during the winters of 1941-2 and 1942-3 is recorded by Harris and Stokes (1942, 1943), working at the Children's Seashore House in Atlantic City. This convalescent home has a relatively stable population, and the children in the wards are confined to their beds, and thus are subject to a minimum of contact or direct-droplet infection. Experimental and control wards were carefully matched; indeed, in the second study (Harris and Stokes, 1943) control and glycol-vapour wards were alternated for three-week periods throughout the respiratory season. Ill effects were not encountered. The germ-load of the air was shown to be greatly reduced by the glycol vapours as judged by direct plate counts. In the preliminary study, 2 respiratory infections occurred in the vapour-containing ward as compared with 16 in the analogous control ward. In the second and larger study, 5 respiratory infections occurred in the vapour-containing wards as compared with 100 in the similar control wards without glycol vapour.

In his report as Associate Referee on Disinfection of Air by Germicidal Vapours and Mists Prof. O. H. Robertson (1943a) writes: "Practical application of the use of glycol vapours for the purpose of controlling air-borne infection has had to await the construction of suitable apparatus for the dispersion of glycol vapours into large enclosed spaces and the development of an instrument to control automatically the concentration of glycol vapour in the air. Rapid progress is being made in the solution of both these problems."

Discussion of dust in industry would be outside the scope of this review. Consideration of the air as a vehicle of infection would be very incomplete, however, without reference to the importance of dust, both as a carrier of pathogenic bacteria and viruses and as a shield of air-borne pathogens against the means used for disinfection of air, such as ultra-violet radiation and germicidal vapours. British investigators (Van den Ende and Andrewes, 1942) in particular, working under wartime conditions, have found dust a very serious obstacle to application of measures for disinfection of air. They have introduced practical methods for reducing dust from floors, textiles, and bed-clothes by treatment with light paraffin oils (Andrewes *et al.*, 1940; Van den Ende and Andrewes, 1942).

* Both hexyl-resorcinol and the glycols are available in the United States.

Experiments on the reduction of the infectivity of dust by floor irradiation with ultra-violet have been instituted by Hollaender, du Buy, Ingraham, and Wheeler (1944). As a result of these experiments they suggest that "floor irradiation be combined with ceiling irradiation in practical tests in barracks or hospital wards to determine the effect, if any, of ultra-violet irradiation in lowering morbidity rates or preventing cross-infection." They caution that "if such experiments be attempted it must be borne in mind that certain types of flooring may prove to be capable of reflecting sufficient amounts of ultra-violet to cause harmful effects."

I have just (April, 1944) been informed by Dr. Edward Bigg that practical apparatus (Bigg and Jennings, 1944) has been constructed and utilized for introduction into the air of properly humidified glycol vapours. Boiling glycol-water solutions are maintained automatically at any desired relative concentration. "The vapours emitted from such boiling solutions are of constant composition and are bactericidal. . . . A predetermined rate of delivery and concentration of water and glycol vapour may be accurately produced by varying the heat input and the temperature of the boiling mixture" (Bigg, personal communication).

Summary

Respiratory disease is responsible for more than a third of the total number of person-days lost to American industry by disability. The air of enclosed spaces is at present the principal vehicle for the dissemination of respiratory disease. The rationale of rendering air safe for human occupancy has been laid down in the laboratory and in suitable controlled human environments. The means are ultra-violet irradiation, dust-suppressive measures, and the use of germicidal vapours of hypochlorous acid and of propylene and triethylene glycol. Elaboration of the practical art of providing safe air-supplies is, however, not to be accomplished cheaply or through the efforts of a few people. A specialty or specialties in sanitary engineering will have to develop around air sanitation, as has occurred around water and milk sanitation. Physicians, air-conditioning specialists, heating, ventilating, and illuminating engineers, the manufacturers of necessary equipment, agencies regulating public health practice, and the industries which will benefit by reduction of industrial disability through respiratory disease ultimately will all have to contribute effort and money to solving the manifold aspects of the problem. How much is it worth to reduce an annual industrial waste equivalent to the output for a year of approximately 470,000 persons?

REFERENCES

- Andrewes, C. H., et al. (1940). *Lancet*, **2**, 770.
 Bigg, E., and Jennings, B. H. (1944). *The Introduction of Glycols for Air Sterilization by a New Vaporization Method*. (In press.)
 ——— and Fried, S. (1944a). *Amer. J. med. Sci.*, **207**, 361.
 ——— (1944b). *Ibid.*, **207**, 370.
 B.L.S. Chart Series (May, 1943). Bureau of Labor Statistics, United States Department of Labor, p. A 15.
 Bourdillon, R. B., Lidwell, O. M., and Lovelock, J. E. (1942). *British Medical Journal*, **1**, 42.
 Council on Physical Therapy (1942). *J. Amer. med. Ass.*, **118**, 298.
 ——— (1943). *Ibid.*, **122**, 503.
 ——— Reports (1942). *Ibid.*, **122**, 29.
 ——— (1943a). *Ibid.*, **122**, 1015.
 ——— (1943b). *Ibid.*, **123**, 92, 2768.
 Douglas, S. R., Hill, L., and Smith, W. (1928). *J. industr. Hyg.*, **10**, 219.
 Edward, D. G. ff., and Lidwell, O. M. (1943). *J. Hyg., Camb.*, **43**, 196.
 ——— Lush, Dora, and Bourdillon, R. B. (1943). *Ibid.*, **43**, 11.
 Flügge, C. (1897a). *Z. Hyg. InfektKr.*, **25**, 179.
 ——— (1897b). *Dtsch. med. Wschr.*, **23**, 665.
 Gafafar, W. M. (1943a). *Publ. Hlth. Rep. Wash.*, **58**, 1250.
 ——— (1943b). *Ibid.*, **58**, 1273.
 ——— (1943c). *Manual of Industrial Hygiene and Medical Service in War Industries* (ed. by W. M. Gafafar), p. 427, W. B. Saunders Co., Philadelphia.
 Harris, T. N., and Stokes, J., jun. (1942). *Amer. J. med. Sci.*, **204**, 430.
 ——— (1943). *Ibid.*, **206**, 631.
 Henle, W., Sommer, H. E., and Stokes, J., jun. (1942). *J. Pediat.*, **21**, 577.
 Hollaender, A. (1943). *Amer. J. publ. Hlth.*, **33**, 980.
 ——— du Buy, H. G., Ingraham, H. S., and Wheeler, S. M. (1944). *Science*, **99**, 130.
 Jennison, M. W. (1942). *Aerobiology*, p. 106, Washington.
 Masterman, A. T. (1938). *J. industr. Hyg.*, **20**, 278.
 ——— (1941). *J. Hyg., Camb.*, **41**, 44.
 Piersol, G. M. (1941). *J. Amer. med. Ass.*, **116**, 1339.
 Robertson, E. C., Doyle, M. E., and Tisdall, F. F. (1943). *Ibid.*, **121**, 908.
 Robertson, O. H. (1943a). *Amer. J. publ. Hlth.*
 ——— (1943b). *Sterilization of Air with Glycol Vapours*. Lecture before Harvey Society, April 15. To be published in 1942-3 *Harvey Lectures*.
 ——— Bigg, E., Puck, T. T., and Miller, B. F. (1942). *J. exp. Med.*, **75**, 593.
 ——— Puck, T. T., Lemon, H. F., and Loosli, C. G. (1943). *Science*, **97**, 142.
 Sommer, H. E., and Stokes, J., jun. (1942). *J. Pediat.*, **21**, 569.
 Trillat, M. A. (1938). *Bull. Acad. Méd., Paris*, ser. 3, 119.
 Twort, C. C., and Baker, A. H. (1942). *J. Hyg., Camb.*, **42**, 266.
 ——— Finn, S. R., and Powell, E. O. (1940). *Ibid.*, **40**, 253.
 Van den Ende, M., and Andrewes, C. H. (1942). *Aerobiology*, p. 281, Washington.
 Wells, W. F. (1933). *Amer. J. publ. Hlth.*, **23**, 58.
 ——— (1943). *Ibid.*, **33**, 1436.
 ——— and Wells, M. W. (1942). *Aerobiology*, No. 17, p. 99, Washington.
 ——— (1943). *Amer. J. med. Sci.*, **206**, 11.
 ——— and Wilder, T. S. (1942). *Amer. J. Hyg.*, **35**, 97.

INTRAVENOUS BARBITURATES IN THE TREATMENT OF HYSTERIA

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The value of intravenous barbiturates in psychiatric treatment remains controversial, despite increased popularity since the outbreak of war. Bleckwenn (1930) is credited with being the first to use intravenous barbiturates in psychiatry; he employed sodium amytal to produce lucid intervals in katatonic schizophrenics, to relieve insomnia, and, in criminological work, to elicit facts from difficult witnesses. Lindemann and Malamud (1934) gave the classical description of the subjective phenomena of light sodium amytal narcosis. They described its characteristic effect as the induction of a feeling of well-being, security, friendliness, and a desire to discuss personal matters not usually spoken of to strangers. Hexobarbitone (evipan) was introduced by Weese and Scharpf in 1932, and two years later was recommended by Hauptmann (1934) as an aid in the production of deep hypnosis. Horsley (1936) described the technique of narco-analysis, using 2½% solution of nembutal and pentothal. He found that psycho-analysis was made considerably more rapid by this method. The value of hexobarbitone in the treatment of neurosis has been stressed by Campbell (1938) and Stungo (1938, 1941). Hadfield (1942) pointed out the value of pentothal in artificially overcoming "blocks" in analysis. Sargent and Slater (1940) found amytal useful in recovering hysterical loss of memory in acute war neurosis. Mallinson (1940) described the technique used in the Navy, and Wilde (1942) reported the use of narco-analysis with pentothal in the treatment of 50 Service neurotics.

Most of the papers on the subject deal with heterogeneous neurotic groups, and tend to stress the advantages of this method of treatment. This paper is limited to one type of neurosis—viz., hysteria—and the results of treatment are compared statistically with those of other psychotherapeutic methods.

The Material

The total material considered consists of 247 successive cases of hysteria admitted to a unit of an E.M.S. neurosis centre. 126 patients received intravenous barbiturate in the course of their treatment. In 19 cases verbal hypnosis was used; the remaining patients were treated by ordinary psychiatric methods without the aid of either intravenous barbiturate or hypnosis. All patients participated in a comprehensive general scheme of treatment, which included various forms of occupational therapy, such as courses of instruction in book-keeping, type-writing, engineering, carpentry, gardening, etc. Remedial physical training formed an integral part of the scheme. Educational lectures and discussion groups also formed part of the patients' activities. Psychiatric social workers were employed when need for them was indicated.

Indications

The main indications for including intravenous barbiturate narcosis in the scheme of treatment were:

1. Cases in which it was considered that ordinary methods of treatment were unlikely to produce speedy recovery.
2. To elicit further information when the causative factors of the case were not clear.
3. To aid production of relaxation in patients with hysterical spastic motor symptoms or contractures.
4. To aid production of deep hypnosis in difficult cases.
5. Cases in which hysterical symptoms had not shown satisfactory improvement, in a reasonable time, at this or other hospitals, by such methods as ordinary persuasion, explanation, and re-education.