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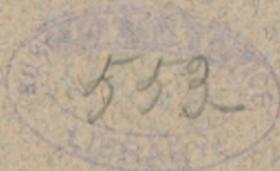
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## THE ANESTHETIC ZONE IN NITROUS-OXID ANESTHESIA.

By JOHN D. THOMAS, D.D.S., PHILADELPHIA, PA.

EVER since nitrous oxid was introduced as an anesthetic, its physiological action has been the subject of study and experiment to ascertain, if possible, how its narcotic effects are produced. After calling out many and various opinions, the controversy seems to have evolved two settled theories. One, that narcosis is produced as the result of depriving the blood of its necessary supply of oxygen, causing true asphyxia; the other, while admitting that nitrous-oxid inhalation produces symptoms of asphyxia, affirms that the gas possesses purely anesthetic properties as well. Practical experience seems to demonstrate that the latter theory is the correct one. So firm is the conviction of many as to the existence of the factor of asphyxia in nitrous-oxid anesthesia, that several attempts have been made by different experimenters to combine nitrous oxid with various percentages of oxygen, with the hope of counteracting the asphyxiating effects, believing that a desirable anesthetic for prolonged operations could be so obtained. Thus far these experiments have not given the result they seemed to promise, if we except the method of M. Paul Bert, which, in a measure, fulfills the requirements, but the apparatus appears to be too complicated to warrant its extensive use.

In the DENTAL COSMOS for May, 1893, Dr. H. C. Wood, who has devoted much time to the study of anesthetic agents and their physiological action, gives the results of five experiments with nitrous oxid upon dogs, from which he draws two conclusions. First, that they are "a confirmation of the view that nitrous oxid produces anesthesia by cutting off the supply of oxygen;" second, "that a mixture of nitrous oxid with oxygen does not seem available as a practical anesthetic." Experience seems to confirm the latter of the two conclusions as probably correct.

The laws of dosage must be taken into consideration in the administration of anesthetics, the same as with other drugs, and while the mixture of three or even five per cent. of oxygen would perhaps be perfectly compatible with children as well as with some adults, it will not successfully produce anesthesia with all.

Resistance to the anesthetic action of nitrous oxid varies much in different individuals. A man whose system would resist the intoxicating effects of an inordinate amount of alcohol will exhibit the same tendency with all anesthetics, so that such an individual cannot be brought readily under the influence of nitrous oxid if it be diluted in bulk with air or oxygen, while one of opposite temperament might easily succumb to a moderate amount of such a dilution with air or oxygen.



Again, the rapid action of the gas and its transitory effects confine the anesthetic stage to such narrow limits that it requires upon the part of the administrator greater experience than can usually be acquired by the regular surgeon to avoid, as Dr. Wood says, "the danger of passing from anesthesia to sensibility, or from partial to complete asphyxia." So it would appear, so far as generally understood and administered, that nitrous oxid is not applicable for prolonged anesthesia or promiscuous use in general surgery.

The research of Dr. Wood has experimentally shown the existence of the anesthetic zone in nitrous-oxid anesthesia, and the conditions which limit its duration and extent. He, however, entertains doubts of its practical utility in surgical operations, because of its evanescent character and the narrow limits which separate it on the one hand from asphyxia, and on the other hand from a sudden return of sensibility. It is the purpose of this communication to show how in actual daily practice the zone of pure anesthetic action is attained and made use of, and how it may be prolonged and the anesthesia controlled in operations, other than the extraction of teeth, which require more time for their proper performance.

The existence of a zone of true anesthesia uncomplicated by asphyxia during the exhibition of nitrous oxid cannot be doubted by any practitioner or competent observer who has practically studied its action upon the human subject. That the evanescent action of the gas, due to its rapid diffusibility, confines the zone of true anesthesia to very narrow limits is likewise true, so that under the conditions which ordinarily govern the administration of nitrous oxid this factor in the physiological action of the gas may be, and probably is, generally overlooked. The importance of recognizing the zone of true anesthesia and taking advantage of it in nitrous-oxid administration requires no argument to defend it, for therein lies the question not only of its safe use, but of the successful production of the true anesthetic state which is necessary for its efficient use in minor surgery.

The anesthetic zone can be preserved from three and four up to eight, nine, and ten minutes, as has been frequently done by the writer, by using the nose of the patient as a valve to admit atmospheric air in sufficient quantities to relieve and avoid the accompanying asphyxia, and no better proof could be offered of the legitimate anesthetic properties of nitrous oxid than is given by cases so treated. To combine atmospheric air with the gas in bulk is not practically applicable, but to admit a small amount during the inhalation, as the disagreeable appearances of the accompanying asphyxia occur, will mitigate the asphyxiating effects in all cases, while in a majority of them they will be entirely obliterated, except perhaps a very slight discoloration of the lips, which no one could claim to be sufficient to produce narcosis by asphyxia. By experience one can detect the stage which marks the anesthetic zone, and, using the nose as a valve to admit atmospheric air as required, can produce complete and profound narcosis, free from asphyxia, the patient meanwhile remaining as calm and placid as when under the action of any other anesthetic.

The evidences of perfect nitrous-oxid anesthesia, independent of the asphyxiating influence, are so abundant that to one in practice the first conclusion of Dr. Wood, that nitrous oxid produces anesthesia by cutting off the supply of oxygen, which he believes to be confirmed by his later experiments, seems to be open to question.

If we accept the symptoms of asphyxia to be discoloration, shortness of breath, violent efforts at expiration and expiratory convulsions, and finally exhaustion, and a feeling of impending suffocation, as is the case when nitrogen is inhaled, and compare them with the symptoms produced by nitrous oxid, they will be found to be greatly dissimilar in many respects.

The inhalation of pure nitrous oxid will produce discoloration to some extent, which may be much or little according to the temperament of the subject; but there is no oppression as of impending suffocation, no violent efforts at breathing nor shortness of breath, while on the contrary there is at the beginning a feeling of stimulation and exhilaration, quickly followed by complete narcosis, from which the patient awakens only with recollections of a pleasurable sensation, with no succeeding languor or lassitude or even giddiness, and the whole space of time occupied is, in a majority of cases, less than two minutes. There may be accelerated heart-beat at the preliminary stage, but this is clearly due to cerebral excitement, caused by anticipation and nervous fear of taking an anesthetic. This rapid heart-action usually subsides to about the normal pulsation when unconsciousness takes place, and very seldom will fall below normal, except in cases of cardiac weakness.

In Dr. Wood's experiments it appears that to produce narcosis in the dog by nitrous oxid required two minutes and thirteen seconds, while by mechanical asphyxia the same was produced in two minutes and nine seconds, four seconds sooner.

Nitrous oxid will produce narcosis in man in from thirty to fifty seconds, a period of time much shorter, I understand, than is required by nitrogen.

The length of time required to produce narcosis by mechanical asphyxia, by experiment upon a human being, would be difficult to ascertain, but some time ago there was a performance given at a theater in Philadelphia by a man under the sobriquet of "The Man-Fish." He exhibited his specialty under water in a glass tank, and if my memory serves me he remained under water for the remarkable space of three minutes and nine seconds, and showed none of the symptoms of approaching asphyxia other than considerable discoloration. Taking that exhibition as a criterion, there could be no parallel between the two in regard to time.

We do have, however, in isolated cases, coincident effects of asphyxia which are, I think, to be ascribed solely to the want of oxidation when the pure gas is given. These consist of cases of constriction of the larynx or glottis, jactitations, opisthotonus, and muscular convulsions, but hundreds and thousands of people take the gas without giving the slightest indication of any of these, and they can be avoided almost universally by the judicious admission of atmospheric air at the proper time, as before alluded to.

There can be no question that the inhalation of pure nitrous oxid does carry with it some symptoms of asphyxia, the oxygen supply being cut off, especially when large quantities are given for the purpose of producing a profound anesthetic impression; but the very rapid production of anesthesia indicates that the nitrous-oxid narcosis takes place much in advance of the effects of the asphyxiating accompaniment, except in very rare instances.

Here it would be well to consider what kind of people are likely to readily succumb to asphyxia.

In a conglomerate population such as we Americans are, we have people from the pale and exceedingly anemic to those of full habit and florid complexion, and the symptoms of asphyxia as produced by the inhalation of pure undiluted nitrous oxid will vary just as much as does the degree of blood-color in each individual between the extremes of the whole line. In the very anemic, heart-failure could be produced before any of the symptoms of approaching asphyxia would present themselves. In a healthy subject of brunette complexion and bilio-sanguinary temperament, perfect unconsciousness can be produced by pure nitrous oxid with absolutely none of the symptoms of asphyxia appearing, other than a slight discoloration of the lips, and this can be completely relieved by the admission of a proper amount of air so that it would be unnoticeable to the inexperienced eye. This class of people no doubt would be slow to succumb to suffocation under any circumstances, yet very easily come under the anesthetic influence of the gas.

Those of light complexion, with rosy cheeks and bright red lips, and those of the full habit and deeply florid complexion, will show to a greater or less extent the asphyxiating appearance, and some occasionally to a marked degree, when the pure gas is given. I have, however, on several occasions seen this condition extend to severe glottis constriction and convulsed muscles under the pure gas, which showed no such tendency by taking advantage of the anesthetic zone and admitting air as before indicated, when they have acted in a perfectly satisfactory manner during the narcosis.

The blood in these florid people seems to require the full amount of oxygen to relieve their systems of the accumulating carbonic oxid, and they are more difficult to handle, but they are not beyond the possibility of accomplishment with exceptional regularity.

There are some cases which from appearances seem to indicate that their blood is constantly in a semi-deoxidized condition; they not only show a dark red color, but their lips are as blue from apparent improper oxidation of their blood as most people show when well under the effects of the gas. Such cases are usually those whose respiration seems decidedly weak. They never breathe to the full capacity of their lungs, and their respiratory motion is sometimes as low as twelve or fourteen to the minute. These will show the asphyxiating effects more rapidly than the anesthesia. They will occasionally exhibit approaching suspension of the respiratory effort before the upper brain could possibly be affected by the anesthetic action of gas, and require the greatest caution in the administration.

Viewing all the varying symptoms of nitrous-oxid narcosis from a practical standpoint, it is clearly evident that the inhalation of the gas produces a dual effect,—viz, that it produces perfect anesthesia independently of any other influence; that its administration carries with it accompanying symptoms of asphyxia, which appear in degree only as the blood of the individual demands a full or partial supply of oxygen during the short space of time required for the inhalations, and this can be relieved by discovering the anesthetic zone and admitting atmospheric air in such quantities as judgment dictates; and that the asphyxia narcosis will dominate the purely anesthetic effects of the

gas only in such cases as are intolerant of the slightest contraction of their full supply of oxygen.

From a personal experience of considerably over one hundred thousand administrations, I am impressed with the conviction that death from nitrous oxid will be produced by strictly physiological effects in but two ways. Other forms of death would seem to be purely coincident or accidental, several of which might happen. A tooth or some foreign body could get into the larynx, or a patient might be strangled by constriction of the throat or swallowing of the tongue; in either case it would be an accident if the operator failed to get the tongue forward and the obstacles removed, or neglected to perform tracheotomy in time. Coincident with the inhalation one might, immediately before or after, be stricken with any one of the many diseases which carry people off, in the car, on the street, or elsewhere. This is liable to happen at any time, and could easily be consequent upon preliminary suffering or the fear and excitement which nearly always accompany the anticipation of taking an anesthetic and undergoing a surgical operation, no matter how slight.

But cases of death which could be legitimately laid to the effects of the gas, or rather the want of oxidation which accompanies its inhalation, comprise those at the two extremes of the line of temperament which I have mentioned,—the markedly anemic and the very florid or deep-red-blooded people,—the anemic young girls who are suffering from the suppressed or retarded functions of womanhood, the marked pallor of the morphia-taker, and the waxy complexion of Bright's disease. The blood of these is so deficient in red corpuscles that the lack of oxygen will be impressed upon the nerves of the heart almost simultaneously with the first breath of the gas, and syncope follow as rapidly as will the suspension of breathing in those cases which mark the other extreme,—viz, the very florid and slow breather; in the one heart-stoppage would be the cause, in the other suspension of respiration, in which the heart would continue to pulsate for perhaps several minutes after. In each of these conditions the result would evidently take place before the upper brain could be affected to anesthesia. These two comprise the dangerous cases from the physiological effects of nitrous-oxid inhalation, and both of them would appear to be from the asphyxiating accompaniment, for they will readily respond to atmospheric admission.

I would here strongly emphasize the condemnation, which on another occasion I iterated, respecting the use of the face-piece in connection with the inhaling apparatus, which idea has been imported from abroad and is used extensively in this country.

The effects of nitrous oxid as they develop are shown most clearly through the mucous surfaces of the lips, so that the administrator can tell at once how much the want of oxygen is affecting the blood, and he can relieve it accordingly. In the event of approaching danger the signs would be seen in the lips, either by too much discoloration in the florid or plethoric habit, or excessive pallor in the anemic, in time to avert disaster; but with the face covered this most reliable index is lost to view, under which circumstances the first indication to apprise the operator of approaching danger would be cessation of respiration, which might occur too late for resuscitation.









