

NOTES ON THE PHYSIOLOGICAL ACTION AND PATHOLOGICAL

EFFECTS OF ETHYLIC ALCOHOL ON THE HUMAN BODY.

Thesis presented for the Degree of Doctor of Medicine,

By

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NOTES ON THE PHYSIOLOGICAL ACTION AND PATHOLOGICAL
EFFECTS OF ETHYLIC ALCOHOL ON THE HUMAN BODY.
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One of the most startling phenomena of our time is the indifference manifested by civilized races to the ravages wrought by the immoderate use of alcohol.

(1)

Norman Kerr calculates that in the United Kingdom alone one hundred and twenty thousand deaths are caused, directly and indirectly, each year by the abuse of this beverage. These figures lead to the conclusion that in the United Kingdom, alcohol is responsible for more deaths than any single disease; a conclusion calculated to arrest the attention and excite the interest of any medical man. And when, as District Medical Officer, in a manufacturing town, one is brought into daily contact with the strikingly diminished mental power, the impairment of physique, the shattered constitutions, impoverished homes, and blighted human lives consequent upon excessive indulgence in alcohol, one is naturally led to enquire into the nature of a substance prone to work such direful effects, and to seek definite information respecting its action upon the functions and tissues of the human body.

The effects of alcohol, as commonly seen, are really the effects of the various alcoholic beverages—brandy, gin, beer, wines etc. And the question arises,

(1) Inebriety or Narcomania 3rd Ed. 1894. pp. 478 & 492

(2) Ridge: Alcohol & Public Health. 2nd. Ed. page 52.

is one justified in assuming that the physiological action and pathological effects of these beverages are due solely to the ethylic alcohol found in notable quantity in all of them ? Or are they due, in considerable part to one or more of the many other substances contained therein ?

(1)

In favour of the latter view Dr William Ewart says:- " Pure ethylic alcohol intoxication is seldom witnessed; it is usually modified by the ethers of wine, by the higher alcohols of spirits, and by the special ingredients in other alcoholic drinks". Or again:-" The convulsive element which sometimes complicates intoxication by spirits, is the most obvious instance of mixed intoxication". Further, :-" The deleterious effects, both acute and chronic, of the malt liquors are also instances of a mixed intoxication varying with their constituents."

In favour of the view that ethylic alcohol is almost solely responsible for the harmful effects produced by alcoholic beverages, Prof. J. J. Abel in a statement of the relative toxicity of the constituents of alcoholic beverages, mentions a number of experiments which seem to prove that the furfurol, higher alcohols, and ethers are found in such slight quantities in any specimen say of rum, whisky, or wines, that they could not possibly produce any marked effect even though they are admittedly much more poisonous than ethylic alcohol. In support of this view Prof. Abel gives the following tables:-

(2)

(1). Encyclo^{ped}ia Medica 1899 Vol. 1 page 119.
(2) Physiological Aspects of the Liquor Problem 1903. (Being the report of the Sub-committee of the American Committee of Fifty appointed to investigate the Liquor Problem), Vol. 2. page 25.

Contents of an average Litre of Rum:-

500.	c.c	of Ethylic Alcohol
0.763	"	" Ethers.
0.153	"	" Aldehydes.
0.384	"	" Higher Alcohols.
0.034	"	" Furfurol.

The toxic equivalents of the foregoing constituents are as follows:-

Of Ethyl Alcohol	7.80	(Joffroy)
" Ethers	4	(Dujardin-Beaumetz)
" Aldehydes	1	(Joffroy)
" Furfurol.	0.14	(Joffroy)
" Higher Alcohols.	1.50	(Dujardin-Beaumetz).

"Assuming now that the toxicity of a given beverage is equal to the sum of the toxicities of its several constituents, we find that:-⁽¹⁾

500.	c.c.	of ethyl alcohol will kill	64.102	kilo-
				grammes
0.763	"	" Ethers	"	" 0.191
0.153	"	" Aldehydes	"	" 0.153
0.034	"	" Furfurol	"	" 0.243
0.387	"	" Higher Alcohols	"	" 0.258
		<u>Total.</u>		<u>64.947</u>

The last table shows that the alcohol contained in a litre of rum will of itself, destroy 64.102 kilogrammes of animal life. And Prof. Abel adds ⁽²⁾ " The by-products are therefore of only secondary importance as toxic agents.....they amount to rather less than ⁽³⁾ one-and-a-half parts by volume in the thousand."

(1). Physiological Aspects of the Liquor Problem Vol 2 (1903) p. 25.

(2) Ibid p.26.

(3) Ibid pp. 11 & 12.

The ethers so commonly present in wines are scarcely more poisonous than ordinary ether, and their amount never exceeds a small fraction of 1%, so it is unlikely that they take much part either in disturbing physiological functions, or in producing pathological lesions.

(1)
With regard to furfurool, Joffroy some 7 or 8 years ago, exhibited a dog in Paris which had been receiving large doses of this substance for a period of 12 months and still remained in good health.

(2)
Respecting amylic alcohol, Pohl had a number of dogs fed for many months- allowing breaks of one or more days- with small quantities of amylic alcohol, and this without appreciable injury. Dujardin and Audige many years ago found that the pig could tolerate Fusel Oil (3) for a long time. In 1884 Stiger, a Swiss Physician, (4) gave it as his opinion that the harmfulness of excessive brandy drinking could not be due to fusel oil, but rather to ethylic alcohol, since the inhabitants of the Jura, amongst whom intemperance and its attendant evils are very prevalent, drink only pure brandy containing no fusel oil.

The American Committee of Fifty for investigating the Liquor Problem, in their report say:- "The Special (5) effects of Alcoholic drinks are mainly due to the alcohol they contain, and, so far as these effects are harmful, the other substances are of comparatively small importance. Fine old whisk^{ie}ys and brandies are nearly as

likely to produce injurious effects as are the cheaper

(1) Physiological Aspects of the Liq. Prob. 1903. p. 29

(2) Ibid page 30. (4) Ibid pages 32 & 33

(3) Ibid page 30 (5) Physiological Aspects of the Liquor Prob. Vol.1 page XX of Report.

grades of the same liquors , if taken in the same quantities.....in general the injurious effect of an alcoholic drink is in proportion to the amount of alcohol contained in it, which seems to be the chief reason why wine and beer are less injurious than distilled liquors".

Probably the effects produced by drinking alcoholic beverages are almost entirely due to the action of ethylic alcohol. Doubtless other constituents, as fusel oil, ethers, aldehydes, etc., produce some effect, especially when large quantities of the beverage are consumed. Still, if we regard all these constituents as poisons, a glance at the toxicity of each, and at the amounts found in various alcoholic beverages, will show that even their combined action is not likely to be very poisonous. Further, it has been proved that ethylic alcohol is a powerful protoplasmic poison, and that of itself it is capable of producing the physiological disturbance observed during a single intoxication, and many of the pathological lesions resulting from continued indulgence.

An exception to the above conclusion must be made in respect of absinthe, a strong spirit flavoured with oil of wormwood, aniseed, fennel, coriander etcetera., the oil of wormwood being present in such quantity as to produce its own decided physiological effects.

(1)

Further, as pointed out by Brunton, the consumption of beer leads to deposition of fat in various tissues, wine produces gout, whilst the drinking of gin leads to loss of flesh. Probably these different effects are due in part at least to substances other than the ethylic alcohol contained in these beverages.

(1). Disorders of Assimilation, Digestion, etc. 1901 p. 130.

THE EXTERNAL ACTION OF ALCOHOL.

Alcohol possesses^{es} great power of absorbing water, and by virtue of this quality causes hardening of all tissues exposed to its action. It is also antiseptic, and exerts a direct toxic action on the organisms which cause putrefaction. Alcohol when applied with friction to a skin surface, acts as a stimulant to the nerve endings found in the parts to which it is thus applied. (1)

Action of Alcohol on the "Cardio-Vascular System"

LOCAL EFFECTS OF ALCOHOL.

If alcohol be applied to the skin and allowed to evaporate, the loss of heat occasioned thereby causes the skin to become pale through contraction of its blood vessels. If, however, evaporation be prevented the skin becomes red owing to dilatation of its blood vessels, the dilatation being brought about by absorption of the alcohol through the skin. " This vaso-dilator action of alcohol is most marked with a solution of 60 to 70%, disappearing with free dilution even though the same quantity of alcohol be used (2) ".

It has been noticed that the blood vessels of the abdominal cavity are of all others the most easily dilated by the local application of alcohol. That this dilatation of blood vessels is due really to the local action of alcohol, is shown by the fact that the blood pressure in the part operated upon is raised much more by an alcoholic compress than by a warm fomentation. (2) (1)

From the local vaso-dilator action of alcohol, and

(1) Hale White's Text Book of Pharm & Therap. 1901. page 106
 (2) Med. Temp. Revw. Novr. 1903. page 326.

also from the fact that if alcohol be injected into the circulation there follows dilatation of the blood vessels through which it passes, it is evident that alcohol affects the peripheral vaso-motor mechanism in the same way that it influences the vaso-motor centre⁽¹⁾.

When taken into the mouth alcohol causes increased vascularity. In strong solution, say the strength of pure brandy, alcohol acts as an irritant to the mucous membrane of the mouth and throat. If pure brandy be retained in the mouth for a short time it produces a burning sensation, and whitens and corrugates the mucous membrane. The whitening is due to coagulation of the albumen of the mucous membrane. The whiteness and burning soon pass away and the coagulation is quickly removed by the circulation⁽²⁾.

In the stomach as in the mouth alcohol produces a sensation of warmth. It also causes dilatation of the blood vessels of the stomach and increased secretion of gastric juice.

REFLEX EFFECTS OF ALCOHOL.

When taken into the mouth brandy causes an increased secretion of saliva, which increase is brought about reflexly. That this action of the brandy is reflex is known from the fact that the increased flow occurs before the alcohol could possibly have become absorbed, or have come into direct contact with the salivary glands.

Alcohol is very quickly absorbed by the stomach and intestine, but even before its absorption it may

influence the cardio-vascular apparatus reflexly, and a
 (1). Monro & Findlay Med. Temp. Revw. Nov. 1903 page 326.
 (2) Brunton. Disorders of Assimilation, Digestion, &c. 1901 page 80.

very large quantity of spirits taken at a draught may by its reflex action produce great depression or even stoppage of the heart. ⁽¹⁾ This reflex action, however, is not peculiar to alcohol, for it may be produced ⁽²⁾ by many foods and drinks. Monro & Findlay cite Briggs as having found that ten or fifteen drops of tincture of capsicum produced a rise of blood pressure the duration of which was equal to, or even greater than, the rise produced after giving the same individual four or six drachms of whiskey. Similar effects can be produced by a draught of any warm pleasant liquid, and to a considerable extent by hot savory food.

Even the sipping or frequent swallowing of cold water causes a great increase of the pulse rate. Monro & Findlay ⁽³⁾ observed that the sipping of a wine glass full of water, generally caused an increase of from ten to 15% in the pulse rate, though, on occasion, the increase amounted to 23%. ⁽⁴⁾ Sir Lauder Brunton also teaches that sipping stimulates the circulation, and cites Kronecker to the effect that the inhibitory action of the vagus on the heart is abolished during this sipping process, and that the pulse rate is greatly increased.

The increase in the pulse rate induced by the act of swallowing is independent of the strength of the alcoholic beverage imbibed, but in order to evoke the reflexes just mentioned, it is necessary to give the alcohol in considerable quantities and in a somewhat concentrated form, as the production of these reflexes

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- (1) Brunton Disorders of Assimilation, Digestion, &c. 1901 p. 82
 (2) On the Use of Alcohol as a Medicine. Reprinted from Glasgow Medical Jrnl. May 1904. (page 3.)
 (3) Med. Temp. Revw. Nov 1903 p. 239.
 (4) Text Bk. of Pharm. Therap. & Mat. Med. 1887 3rd Ed. p. 193.

is dependent upon the irritant action of the alcohol on the mucous membrane of the mouth and stomach.

ACTION OF ALCOHOL ON THE "ISOLATED" HEART.

It has been shown that alcohol increases the rate of the heart's action reflexly. Does it ^{also} increase that rate by direct action upon the heart itself? Many experiments have been resorted to with the object of gaining a conclusive answer to this question. Prof. Abel ⁽¹⁾ cites experiments made by Martin & Stevens on the isolated heart of a dog. In Martin's method of experiment the lungs are retained in connection with the heart, and are ventilated by the help of an artificial apparatus in order to keep the blood supplied to the heart sufficiently arterialized. This method is known as the cardio-pulmonary method. ⁽²⁾ Martin and Stevens found that "when defibrinated blood containing one half of one per cent by volume of ethyl alcohol is supplied to an isolated dog's heart which has been hitherto working with uniformity, the invariable result is a very rapid and marked diminution in the work done (indicated by the quantity of blood pumped out from the left ventricle) by the heart in a given time. When the blood contains only one fourth of one per cent of alcohol, the result is in most cases the same, but sometimes it is little or none. After the action of the alcohol has been fully manifested, the heart can in many cases be restored to its original working state if supplied with defibrinated blood containing no alcohol. Blood containing but one eighth of

(1) Physiological Aspects of Liq. Problem Vol.2.p47.

(2) Quoted by Abel. Ibid-pages 47 & 48

"one per cent of alcohol exerts no influence upon the work done by the heart at least for several minutes."

(1)

In a second paper Martin says:- " We have made a few experiments to see what doses of alcohol given by the stomach to a dog will produce some similar action on the heart.....and all we can say as yet is, that to get any direct influence on blood pressure one must put much more alcohol into the stomach than an amount equal to one-fourth per cent of the total blood of the animal. It is either not absorbed fast enough to reach at any moment the heart poisoning limit, or more probably, is picked up by other organs, very likely the liver, and held back from the heart."

(2)

Abel affirms that Martin failed to give practical significance to these results, because he did not find the actual percentage of alcohol in the blood, necessary to produce such and such symptoms, when alcohol was given by the mouth. Gréhant's⁽³⁾ experiments throw light upon this point. He found that very large quantities of alcohol must be taken by the mouth, in order that the conditions which obtained in the experiments of Martin and Stevens on the "isolated" heart might be realised.

In order that the blood may, for a time at least, contain one eighth of one per cent of alcohol, an individual weighing 150 lbs. would need to drink about six ounces of whisky, say in the course of an hour. Most toxicologists would admit, that a single indulgence of this kind would not depress the heart itself more than was found to be the case in Martin's experiments with, say, one eighth of one per cent in the blood.

(1) Cited by Abel. Physiological Aspects Liq. Prob. Vol. 2. p48

(2) Ibid page 49.

(3) Ibid pp. 49 & 50.

(1)
 Sir Lauder Brunton states that in poisoning by alcohol "the heart continues to beat although the respiration may be paralysed, but if a sufficient dose of alcohol be administered, and respiration be kept up artificially in an animal so as to allow the drug to act upon the heart, the cardiac ganglia may also become paralysed".

Marcet, Lallemand, Perrin, and Duroy, Orfilia, and (2)
 Roger Collard all observe that in dogs and frogs poisoned with alcohol, the heart continued to beat three minutes after respiration ceased. (3)
 Monro and Findlay mention an experiment by Haskovec in which he injected 10 c.c. of a 79% solution of alcohol into the jugular vein of a weakly curarised and atropinised dog, after ligaturing the aorta at its root, and he found that the heart came to a standstill before respiration ceased. It was observed by Haskovec moreover, that the exposed heart continued to beat for six minutes after ligation of the aorta, but, if in addition to the ligaturing, the above mentioned amount of alcohol was injected into the jugular vein the heart did not pulsate for more than two minutes.

(4)
 Abel mentions three investigators, Castillo, Eagleton, and Cerna, who affirm that they observed a stimulation of the "isolated" heart after the application of alcohol to this organ. Castillo finds that the heart beats more frequently for a space of from three to ten minutes, in a solution containing one to two per cent of alcohol.

(1) Text Bk. of Pharm. Therap. & Mat. Med. 1887 page 770

(2) Med. Temp. Revw. Nov. 1903 page 331. Cited by Monro & Findlay.

(3) Ibid. pp. 331 & 332.

(4) Physiological Aspects of the Liquor Prob. Vol 2 p. 53

Eagleton finds that " in solutions containing 0.25 % of alcohol, but little effect on the pulse rate is observed."

Cerna considers that a 0.1% solution of alcohol has no perceptible action on the frog's heart, but solutions of 0.5 to 2% he thinks, distinctly increase the rapidity of the heart's beat.

(1)

Abel points out that the dose of alcohol necessary to place 0.5 to 1% of alcohol in the blood is very large indeed, and would cause profound intoxication. He further points out that these investigators" did not make use of a nutritive solution to keep the heart in a normal condition, but placed the excised heart directly into the alcoholic solutions;" and he states that"these experiments violate every rule of experimental pharmacology".

Probably alcohol in moderate doses has little or no direct action on the healthy heart. But this statement does not take note of the pathological changes which are often found in subjects who for a lengthy period have taken small oft-repeated doses. The heart may be quickened reflexly by alcohol, and alcohol may also influence the heart by acting on the central nervous system.

(1) Physiological Aspects of the Liquor Problem Vol 2
pp. 53 & 54.

THE ACTION OF ALCOHOL ON ISOLATED BLOOD VESSELS.

Having noted the action of alcohol on the "isolated heart", it is now convenient to enquire into its action upon the blood vessels, when disconnected from the central nervous system, and from the heart. There seems no reason to doubt that alcohol in moderate doses will dilate the peripheral arteries whilst they are still connected with the heart and ~~the~~ central nervous system, but experiments have not proved satisfactorily how this dilatation is brought about: ^{i.e.} whether it is due to the action of alcohol on the controlling centres, or to its direct action on the walls of the vessels. To attempt to settle this point investigators have had recourse to "perfusion experiments". These experiments are carried out on cold blooded animals, and consist in passing defibrinated blood through blood vessels which have been detached from the heart. The central nervous system is destroyed prior to the perfusion of the blood through the vessels. Arterialized blood under a known pressure is forced into the artery. The normal outflow from a vein is then measured and compared with that obtained when the blood containing alcohol is passed through the vessels. An internal organ, say the kidney, or an extremity of a warm blooded animal may also be used for perfusion experiments, and in the following table

(1)
 Kobert gives the result of experiments of this kind with the foot of a calf:-

(1). Cited by Abel in Phys.Aspects of the Liquor Prob.
 Vol.2. page 56.

Amount of Alcohol in thousand parts of blood perfused.	Time of the observed perfusion in minutes.	Alterations in the velocity of outflow in per cent-age.	Amount of alcohol in Milligrams perfused during the experiment.
1	15	8	40
1	10	0	60
2	11	5	72
2	13	0	98

Only in one of the four experiments was an increased outflow observed. After these experiments Kobert (1) stated " Alcohol and chloroform do not influence the velocity of outflow in any noteworthy degree. A fall in the blood pressure is only observed after large doses of these agents, and then evidently has its cause in their action on the vaso-motor centre." It seems probable from these experiments that small or even moderate doses of alcohol have no direct effect on the walls of the blood vessels. Prof. Abel states (2) that " very large amounts no doubt have a direct dilating action on the vessels like that shown for the heart itself".

THE ACTION OF ALCOHOL ON THE PULSE RATE.

Here as in other sections of the subject there is found considerable difference of opinion. (1) Some authorities declare that alcohol after absorption increases (3) the pulse rate. Amongst these are Parkes and Wollowicz (4) (5) (6) (7) Anstie, Richardson, Binz and Hale White.

(1) Quoted by Abel Phys.Aspects Liq.Prob.Vol.2 Page 56

(2) Ibid.

(3) Proceedings Roy.Soc.Lond. 1869 -70 Vol.18.p.369.

(4) Stimulants & Narcotics 1864 p.410.

(5) Cantor Lects. 1875 pages 50 & 51.

(6) Lects. on Pharm.Transl.New Syd.Soc.1895 pp.320 & 321

(7) Text Bk.of Pharm.& Therap. 1901 page 110.

(2). Others affirm that there is a slowing of the pulse after absorption of alcohol.

(3) Others again assert that after temporary slowing there is acceleration of the pulse rate.

(4) Whilst Dogiel and also Parkes ⁽¹⁾ (in his later experiments) speak of a temporary increase, followed by a diminution of the pulse rate.

(5) Besides these, who display such a diversity of opinion, there are many others who state from experiments that alcohol after absorption causes little if any change in the pulse rate, amongst whom are Bunge, Zimmerberg, and Hare.

Parkes and Wollowicz carried out their experiments as follows:- For a period of twenty-six days the man experimented upon was given a similar diet and took his meals at the same time each day. On the first eight days he took no alcohol. On the next six days he took rectified spirits in divided quantities, amounting altogether on the first day to one fluid ounce of absolute alcohol; on the second day the amount was two fluid ounces; on the third day four ounces, and on the fifth and sixth days eight ounces each day. Then the alcohol was discontinued for six days. Then he took each day twelve ounces of brandy containing forty-eight per cent of alcohol. Then for three days more he drank only water. The person experimented upon was a man aged twenty-eight, and in good health. He had been accustomed to one or two pints of beer daily, but abstained for ten days prior to the commencement of

(1). Proceedings of the Royal Soc Londn. Vol 22.1873-4
page 182

the experiment. He was under observation from 8 a.m. to 10 p.m. The pulse was counted about every two hours whilst he was in a recumbent position. The pulse was more frequent when alcohol or brandy was given, but it ought to be noted, that although the pulse was counted whilst the person experimented upon was in a recumbent position he was allowed exercise between the times of counting. It was calculated by Parkes and Wollowicz⁽¹⁾ that during the last two days when alcohol was given the heart was doing one-fifth more work than it did under normal conditions.

⁽²⁾
Rosenfeld summarising his views upon the effect of alcohol on the pulse rate, concludes that in a healthy individual the effect is inconsiderable and appears sometimes as a slight retardation, at others as a slight acceleration. While Ringer and Rickards⁽³⁾ have stated that there is a slowing of the pulse rate in healthy individuals.

⁽⁴⁾
V. Jaksch describes observations on 36 children suffering from various diseases, in which, ~~he found~~ after the administration of 20 c.c. of red wine (which equals about 1.3 c.c. of alcohol) ~~or~~ administration of 8 c.c. of Cognac (which equals 3.2 c.c. of alcohol), he found a slowing of the pulse rate in twenty-six cases, an increase in four, and no change in the remaining six. The slowing occurred from 10 to 15 minutes after giving the alcohol and lasted for a short time, never more than two hours, after which the pulse rate increased to the normal and frequently exceeded the original rate.

(1). Proceedings Roy. Soc. Lond. 1869-70 Vol .18 p.390.

(2) Cited by Monro & Findlay Med. Temp. Rev. Jan 19/04 p.13

(3) "Lancet" 1866 Vol 2 p209; (4) Phys. Asp. Liq. Prob 7/03 p45-6

At a later period than the time of the experiments
 (1)
 already mentioned, Parkes in a fresh series of obser-
 vations obtained very different results from those
 mentioned under heading 1. ^{(see page 14).} The subject of these
 investigations was a healthy man aged 25. The pulse was
 taken on an average twenty-three times a day between
 6 a.m and 10 p.m., the man again being in the recum-
 bent position when the pulse rate was taken, and remain-
 ing in bed until two o'clock every day. The following
 (2)
 are the mean pulse rates observed:-

Days.	Before Brandy.	11 o'clock days	Brandy	Amount.
1	76.3	7	75.4	1 oz.
2	79.9	8	73.3	2 ozs.
3	77.0	9	77.2	4 "
4	77.2	10	77.2	6 "
5	72.6	11	73.9	6 "
6	71.8			

The average pulse rate for the whole water period was 75.67 and the average for the whole brandy period was 75.47. The brandy did not increase the mean pulse rate of the entire day, but it increased the rate of the pulse during the three hours immediately following its administration. So Parkes concluded that alcohol increased the frequency of the heart's beat to the extent of from 5 to 10 beats per minute during rest, and more than this when exercise was taken; that the mean pulse rate of the 24 hours was not increased unless the dose of alcohol was large, and repeated; that the

(1) Proceedgs. Roy. Soc. Londn. 1873 & 4 Vol. 22 pp 172 -190

(2) Cited by Monro & Findlay Med. Temp. Revw. Jany 1904 p. 9

heart beat less frequently than formerly when the effect of the alcohol had passed off.

Probably most investigators of this subject would agree with Parkes' ^{later} summary of the Action of Alcohol on the Pulse Rate.

(1)
Rolleston for example considers that alcohol by increasing the action of the heart and thus increasing the blood supply to the nerve centres, enables a man "to spurt but not to stay", and Sir Lauder Brunton (2) expresses a similar view. But though this may be regarded as a general result no doubt personal idiosyncrasy accounts for some of the differences observed by investigators of this subject.

(3)
Zimmerberg experimented on frogs, dogs, cats, and also on men, and from these experiments he concluded that alcohol in moderate doses caused no quickening of the pulse rate, either in man or in unfettered animals, if "proper precautions were taken against local irritation and movements of the body".

The experiments on men were carried out as follows:- In order to limit the movements of the body, the men experimented on were put in bed. The alcohol used was sweetened with sugar, and in one case cochineal and quassia were added, so that the man might believe he was taking a medicine. All the six men experimented upon were accustomed to the use of alcohol, and their ages ranged from 19 to 58 years. The quantities administered varied from 3 to 6 ounces of a solution containing 44% of alcohol. In no case was there a change (4) in the pulse rate. Martin & Stevens repeated Zimmerberg's

(1) Cited by Monro & Findlay Med. Temp. Revw. Jany 1904 p11

(2) Text Bk. of Pharm. Therap. & Mater. Med. 1897. 3rd Ed. p769

(3) Cited by Abel. Phys. Aspects Liq. Prob. 1903 pp. 36-7

(4) Cited by Abel. Ibid page 38.9

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(3) Cited by Abel. Phys. Aspects Liq. Prob. 1903 pp. 36-7

(4) Cited by Abel. Ibid page 38.9

work, using similar doses of alcohol, and they give in the following table the results of an experiment on a young man, aged 26, unaccustomed to alcohol. These results are practically identical with those obtained by Zimmerberg:-

Hour P.M.	Pulse rate per minute.	Notes.
9.05	74	Subject laid down on bed at 9 p.m
9.15	75	
9.25	71.5	.
9.27	73	
9.30	72.5	Drowsy.
9.42	67.5	
9.50	69	Aroused.
9.58	68	
10.08	-	(45 c.c. of water & sugar administered immediately before).
10.10	73	
10.15	72	15 c.c of alcohol in 15 c.c. of) water)
10.25	71	
10.30	70)
10.31	-	
10.35	71	Complained of slight dizziness.
10.40	70	
10.45	72	
10.52	70	
11	67	
11.07	69	
11.19	68	
11.25	67	
11.35	68	
11.48	70	
12.00	68	
a.m.		
12.10	69	

(1)

Monro & Findlay after numerous experiments, affirm that " it may safely be concluded that even in healthy persons there is great individual variation in the effects of alcohol on the pulse rate. In some cases, alcohol, whether given in a single dose or in several doses throughout the day, and whether given in larger or smaller quantities, increases the pulse rate for that part of the day during which the person is under

observation. More commonly, however, the pulse rate remains the same on alcoholic as on non-alcoholic days, especially if the alcohol is given in one dose".

The action of alcohol on the pulse rate is summarised by Monro and Findlay as follows:-⁽¹⁾ " A slight acceleration of the pulse is frequently but not constantly observed after the administration of alcohol. This acceleration, however, does not as a rule imply an increase in the mean pulse rate for the entire day, and indeed that rate is sometimes diminished".

THE ACTION OF ALCOHOL ON THE PULSE WAVE.

(2)

Parkes & Wollowicz state that in their experiments "they found the pulse to be fuller and softer to the touch after alcohol had been administered".

(3)

Monro & Findlay speaking of the pulse tracings which Parkes & Wollowicz produced, remark:- " They do not convey the impression that alcohol has any very marked effect unless administered in somewhat large doses"; also, that the pulse tracings obtained from the same man, when taking 10 oz. of Claret to dinner, show a reduction of tension; whilst in the tracings taken on the days when he was taking 20 oz. of Claret there is no change from the normal. Richardson held that alcohol produced an increase in volume and a diminution in tension, and that it causes a diminution of tension is

(1) Med. Temp. Revw. Jany. 1904 page 21.

(2) Proceedgs. Royal. Soc. Londn. 1873-4 Vol. 22 p. 190.

(3) Med. Temp. Revw. Feb. 1904 p. 37.

(4) Cantor Lectrs. 1875 pages 49 & 52.

(1)
the opinion expressed by Leonard Hill.

Many observers believe that alcohol raises the pulse tension in sickness if not in health. For example; Binz (2) considers that alcohol causes relaxation of the arteriòles which, he affirms, "are usually greatly contracted in cases of high fever" (3). Wood found no increase of the size of the pulse or in arterial pressure on giving alcohol to animals whose hearts were failing under chloroform anaesthesia, on the contrary he found that when alcohol was given "in sufficient dose to exert any perceptible influence" (4), it always increased the cardiac weakness. Monro and Findlay after numerous tests remark:- " Our own observations lend no support to the theory that in the healthy there is ever an increase in the pulse tension"..... "whenever the quantity of alcohol is sufficient to cause a change, that change is in the direction of increasing volume and diminution in tension".

-:-:-:-:-:-:-:-:-

(1) Schafer's Physiology 1900 Vol.2. page 80
 (2) Lectrs. on Pharm. Trans. New Syd. Soc. 1895 page 336
 (3) Therapeutics-Its Princps. & Practice. 11th. Ed. 1902 page 115.
 (4) Med. Temp. Revw. Feby. 1904 page 37

VASO-MOTOR PHENOMENA CAUSED BY ALCOHOL.

=====

Alcohol leads to dilatation of the small blood vessels of the skin, especially those of the face and hands. This effect may be noticed four or five minutes after imbibition of a moderate quantity, say one ounce of whisky, and is due to enfeeblement or paralysis of the vaso-motor centre. ⁽¹⁾ Monro & Findlay cite Dogiel as showing that after administration of alcohol both the reflex and direct excitability of this centre are lost.

The calibre of blood vessels is controlled by vaso-constrictor and vaso-dilator nerves. The blood vessels of the skin are supplied chiefly by the vaso-constrictors and the dilatation of the blood vessels of the skin caused by alcohol is ascribed by many authorities to paralysis of the vaso-constrictor nerves. Other authorities, however, assert that the dilatation is due to stimulation of the vaso-dilator nerves. Considering that alcohol according to most authorities, ⁽²⁾ Sir Lauder Brunton included, paralyzes the nerve cells, it scarcely seems likely that it can have a stimulant effect upon the vaso-dilator nerves.

Since the amount of blood in the body is limited, and alcohol dilates the blood vessels of all the skin, one instinctively asks:- does not this imply constriction of the blood vessels in some other part of the body?

⁽³⁾ Monro and Findlay cite Foster and Haskovec as favouring

(1) Med. Temp. Revw. Feby 1904 page 43.

(2) Text Book of Pharm. Therap & Mat. Med. 1837 p.769.

(3) Med. Temp. Revw. Feb. /04 page 44.

In a second experiment Hemmeter used defibrinated blood to which alcohol had been added in sufficient quantity to make a 10% solution; the measurements were made at intervals of two minutes. The following tables give the results obtained:-

Under normal conditions.		Under Ethyl alcohol.	
A.	B.	A.	B.
Volume of Stream in c.c. per second.	Mean velocity m m. per second.	Volume of Stream in c.c. per sec.	Mean velocity m m. per second.
0.33	190	1.6	338
.25	142	1.3	339
.28	142	2.0	410
.33	190	2.3	432
.23	143	2.5	460
.19	140	2.0	416

Average of 6 measurements under normal conditions
158 m m.

Average of 6 measurements under 10% ethyl alcohol 399.1 m m.

Increase of current under alcohol 241.1 mm.

(1)
Hemmeter also made observations on the crural arteries and found an increase in the rate of the blood current after the administration of alcohol. He concluded that this increase in the velocity of the circulation was due to diminished peripheral resistance, consequent on the distension of the small blood vessels by the alcohol.

(2)
Monro & Findlay state:- There have been very few experiments dealing with this point, and the results obtained so far are contradictory and inconclusive.

(1) Med. Temp. Revw. Febry. 1904 page 49 Cited by Monroy and Findlay.

(2) Ibid. "

THE INFLUENCE OF ALCOHOL ON BLOOD PRESSURE.

Consulting the literature of this subject one's attention is drawn to the experiments of Zimmerberg, who carried out investigations on men and various animals as frogs, rabbits and cats. His experiments would seem to be of special use because he endeavoured to conduct them under conditions corresponding as nearly as possible to those of actual (1) life. Prof. Abel cites experiments of this investigator.

A cat of average size has 60 c.c. of a 40% solution of alcohol (by volume) injected into the stomach, with the result that a fall in the blood pressure and in the pulse rate was observed. In a second experiment Zimmerberg injected the same amount of alcohol into the stomach of a large cat obtaining a similar result, except that the blood pressure did not fall so quickly.

(2)
Respecting these experiments Prof. Abel remarks "although " the amount of alcohol injected was unnecessarily large " it must be remembered that alcohol was not thrown "directly into the circulation"....."they serve to "demonstrate that alcohol may be introduced into the "stomach of a cat in quantities sufficient to cause "intoxication in less than half an hour without raising "the blood pressure. In fact a steady decline in both "blood pressure and pulse rate is observed"

(3)
Zimmerberg also experimented with moderate doses of

(1) Phys. Asp. of The Liq. Prob. 1903 VOL. II p. 59.

(2) Ibid p. 59.

(3) Cited by Abel. Ibid. p. 59

alcohol, injecting it into the jugular vein. A cat of average size was used in this case. 11 c.c. of a 30% solution of alcohol (by volume) were injected in three portions into the jugular vein. The effects were as follows:-

<u>Time</u>	<u>Blood Pressure</u>	<u>Pulse in 10 sec.</u>	<u>Remarks</u>
	148. m.m.Hg.	38.5	Maximum blood pressure 150 m.m. Minimum blood pressure 146.m.m. Observations continued for one minute.
0.00	First injection of 5 c.c. of the alcohol. Time employed in the injection 42 seconds.		
0.20	150	36	Movement
0.42	140	31.5	
0.57	138	31	
1.12	144	31	
1.14	<u>Second</u> injection of 1 c.c. of the alcohol.		
1.50	142	29.5	
1.52	162	27	This maximum pressure continued for a short time only, & was caused by the violent movements on the part of the animal.
3.00	<u>Third</u> injection of 5 c.c. continued during one minute.		
3.20	144	26.3	
3.37	130	25	
4.07	102	22.5	
4.48	128	23.5	
5.07	134	23.5	
5.45	142	23	Reflexes entirely normal.

With regard to these experiments, Abel says

" no rise of blood pressure occurs except in connect-

" ion with muscular movements" and Zimmerberg himself

summarises the results of his experiments as follows--

" If we survey the results of all our experiments, we

" find that in all those in which the pulse rate was

" determined in unfettered animals and in human beings,

" alcohol caused no increase in the frequency of the

" heart's contractions. These experiments also show

" that alcohol causes a slight fall of temperature,

" and finally in large doses a lowering of arterial

" pressure. In the light of these experiments, one is

" not only justified in denying to alcohol any stim-

" uating power whatever for the heart, but on the

" contrary in declaring that it lowers the working

" capacity of that organ!" In Schaefer's

Physiology we find the following statement:--" Alcohol

" lowers arterial tension!" Vol. 2 p. 80.

(3) (4)

Other observers, as Professors Fraser & Wood,

hold the view that in small or moderate doses alcohol

causes an increase of blood pressure. For example;

(5) Fraser states" If we examine the circulation a

" little more we find that the pulse at the wrist beats

" faster and becomes larger and more full, and that the

" strokes of the heart are stronger". With regard to

large doses all authorities are agreed that they

cause a fall in blood pressure. Binz speaking of blood

(1) .Ibid P. 60.

(2) Ibid p 61.

(3) "Health lectures for the people" 1890. p. 187

(4) "Therapeutics: its Principles & Practice". 1902
11th ed. p. 276.

(5) "Health Lectures for the people". 1890 p. 187.

(6) Lectures on Pharmacology. 1895 Trans. New Syd. Soc.
p. 342.

pressure in acute alcoholism ~~mentions that the arterial~~
 mentions that the arterial pressure of a healthy dog
 fell from 100 to 140 m.m. of mercury to 70 m.m. after
 the administration of an amount of alcohol sufficient
 to induce narcosis, but "insufficient to endanger life".

After many experiments Rosenfeld came to the
 conclusion that small, and even fairly large doses of
 alcohol had little or no effect on the blood pressure;
 so according to Rosenfeld alcohol is not really a stim-
 (1)
 -ulant. Monro and Findlay quote Cook & Briggs, who, after
 numerous experiments state:- "When given by the mouth
 " alcohol produces no greater or more permanent rise
 " in blood pressure than does the administration of
 "much smaller doses of such irritants as tincture of
 " capsicum. A similar and equally transient rise
 " follows the hypodermic injection of undiluted
 "brandy in the usual doses. On the other hand, as large
 "amounts as 30 c.c. (a little over an ounce) of 90%
 "alcohol may be introduced beneath the skin without
 "producing any rise in the blood pressure, provided the
 "alcohol be diluted sufficiently with normal saline
 "solution to eliminate the irritant effect on the
 "tissue that it has in concentrated solutions. True
 "stimulants when administered in this manner elicit on
 " the contrary a positive vaso motor response. "

Quite a number of ~~experiments~~ have been carried
 out on animals in which the spinal cord has been cut
 through between the first and second cervical vertebrae,
 thus severing the vaso motor centre from its connection

(1) Med Temp. Revw. March 1904. pp 72/3

with the peripheral arteries. In many of these experiments there has been a notable rise of arterial pressure after the administration of alcohol to the animal; in consequence of which some writers have argued that alcohol has a stimulant action on the heart itself. Professor Abel,⁽¹⁾ however, points out that this conclusion is probably incorrect, first, because it has been shown that alcohol administered in moderate quantity has little or no action on the "Isolated Heart" and certainly is not stimulant to the heart when isolated. Second, because even after section of the upper part of the cord it is found that slight fluctuations of blood pressure are to be observed, whilst rapid injection of .75 solution of common salt in small quantities often produces as great a rise of blood pressure as do small quantities of alcohol. Further, Abel⁽²⁾ states " An explanation of the slight "blood pressure raising action of small quantities " of alcohol as shown in the majority of cut cord " experiments above described cannot be given without "further experiments.....We have seen "that in respect to the circulatory apparatus its "usual action is that of an indirect stimulant only"

⁽³⁾
 And Professor Monro says:-" Observation shows " that in intoxicating and deadly doses alcohol causes " a fall in blood pressure.....the most recent "researches point to the absence of any rise, and to the " occurrence of a distinct fall in pressure. If alcohol

(1) Phys. Aspects of the Liq.Prob. 1903. p.80

(2) Ibid p. 88

(3) On the use of Alcohol as a medicine.Reprinted from the Glasgow Medical Journal May 1904. P.6.

"is given by the mouth, or by the rectum, or hypodermically, it causes a reflex rise owing to the tissue irritation it produces.....absorbed alcohol cannot raise the blood pressure whether that pressure is normal or below normal to begin with".

"In moderate quantities" says Professor Abel (1) summing up this subject, "alcohol has no appreciable effect on the arterial blood pressure. When a change in this becomes apparent it is always in the direction of a fall and not of a rise. An exception is seen when the spinal cord is severed in its upper portion. In this case a small and temporary rise of pressure follows the rapid injection of diluted alcohol, except in those instances when the blood pressure is very low, say 30 m. m., or below. It is assumed that an anomalous condition of some part of the circulatory apparatus accounts for this unusual effect!"

(1) Physiological aspects of the Liq. Problem. Vol. 2.
p 91.

THE INFLUENCE OF ALCOHOL ON THE NERVOUS MECHANISM OF
THE HEART.

--:--:--:--:--:--:--:--:--:--

After alcohol has been absorbed an increase in the pulse rate is often observed, and one is led to ask "by what mechanism is this increase brought about"?

It might be due to inhibition of the vagus, stimulation of the augmentor-mechanism, arterio-capillary dilatation, or to direct stimulation of the heart and authorities are found to support each of these views. Some, as

(1)
Brunton, believe there is stimulation of the motor cardiac ganglia. All authorities admit that depression follows at a later stage and also when alcohol is administered in large doses. The truth seems to be that in moderate doses alcohol has little or no effect upon the nervous mechanism of the heart, and that in this respect alcohol is similar to opium, acting as a narcotic solely. Indeed, in poisoning by alcohol, as by opium, death occurs through failure of the respiration, the heart continuing to beat some time after respiration

(2)
has ceased. Monro & Findlay speaking of this subject say:- " We have no proof that alcohol is capable of acting as a stimulant to the cardiac muscle, and when an increase takes place in the cardiac rate after alcohol, it is best explained in the meantime as a result of the arterio-capillary dilatation. At least, it is an expression on the part of the organism of an attempt to maintain a uniform blood pressure, whether that uniformity is threatened by vaso-dilatation alone, or by vaso-dilatation combined with cardiac weakness.

(1) Text book of Pharm. Therap. &c. 1887 p 316. Cited

by Monro & Findlay.
(2) Med. Temp, Revw. March 1904 p 78.

THE INFLUENCE OF ALCOHOL ON THE FORCE OF THE CARDIAC
CONTRACTION, OR ON THE WORK DONE BY THE HEART.

-:-:-:-:-:-:-:-:-:-

(1)

Hale White affirms that alcohol causes:- "Not only a more rapid beat but also a stronger contraction, especially of the left ventricle". And many experimenters hold a similar view, namely, Richardson, Parkes,⁽²⁾ Wollo^wicz . No doubt the heart does contract with greater force after the administration of small or moderate doses of alcohol, but this effect is brought about reflexly by stimulation of sensory nerves.

As to whether the heart does more work after alcohol seems to depend on whether there is contraction of the blood vessels in the splanchnic area in proportion to the dilatation of the blood vessels of the skin. If the two factors just named are in proportion then there is no additional work for the heart to do. If on the other hand there is not a corresponding contraction of the blood vessels in the splanchnic area, there must be either an increase in the force of the beats, or an acceleration in the number of the beats, in order to maintain uniformity of blood pressure.

(3)

Monro & Findlay summarise this subject as follows:-

"Alcohol after its absorption is incapable of improving the working capacity of the heart unless the latter is embarrassed by tightly contracted arterioles. If the vessels are already relaxed, as in fevers, alcohol

cannot possibly help the heart, except by producing

(1) Text Book of Pharm. & Therap. 1901. page 110.

(2) Cited by Monro & Findlay. Med. Temp Revw. Mar 1904 p 79

(3) Med. Temp. Revw. Mar 1904 page 82.

effects are possible because of the vaso-motor paresis produced by alcohol.

Alcohol then transforms an animal from a homoio-thermic to a poikilothermic condition.

(1)
 (2) Richardson, Sir Lauder Brunton, and others believe that the lower bodily temperature just spoken of is brought about largely by increased radiation of heat from the distended blood vessels. Binz (3) and others believe that alcohol lowers the temperature by diminishing tissue metamorphosis.

(5) Bevan Lewis after making a number of calorimetric experiments on rabbits, concludes that "The characteristic action of alcohol is that of greatly increasing the heat production, whilst dispersion of the freshly formed heat is facilitated by peripheral vaso-motor paresis".

Authorities are agreed that it is only when the inhibition of alcohol in large doses is associated with exposure to extreme cold that a very low bodily temperature is produced, as in the case of a drunken person exposed to the weather in mid-winter.

The lowest temperatures observed during life are found in drunken persons exposed to extreme cold.

(6) Speaking on this point Binz makes the following statement:- "The decline in the temperature of the body, which follows the combined action of alcohol and

(1) Med. Temp. Rev. April 1904 page 107.

(2) Cantor Lectures 1875 Page 70.

(3) Disorders of Assimilation, &c. 1901 page 89.

(4) Lectures on Pharm. Trans. New Syd Soc. 1895. pp 325-6&7

(5) Journ. Ment. Sc. 1880 p. 20.

(6) Lectures of Pharm. Trans. New Syd. Soc. 1895 p 342.

considerable external cold, is astonishing. Magnan reports that the (rectal) temperature of a woman who had been thoroughly chilled and who was in the habit of drinking fell to 26 deg. C (78.8 deg.F). The patient recovered within eight hours, in so far that her temperature rose to 37 deg.C(98.6 F) and remained at that point. A number of cases were collected in Hamburg, among which was that of a drunkard of 34 who was taken to the hospital in February after spending the night in the open air. The rectal temperature in this case was 24 deg.C.(75.2 F); ten hours later it had only reached 32. 6. deg.C(90.68 deg.F) whilst it did not return to the normal until 24 hours had elapsed".

If a healthy rabbit be exposed to intense cold, the temperature falls by 5 deg.F whilst the temperature of an alcoholised rabbit exposed to the same cold may fall as much as 34 deg. F., and similar effects have been noticed in the guinea pig.⁽¹⁾

The study of the effects of alcohol on the bodily temperature introduces one to another of the apparently contradictory actions of alcohol on the human body, for we find that it gives rise to a feeling of warmth, whilst at the same time it is causing a reduction of the temperature of the body. By its oxidation in the tissues, alcohol produces heat, and yet by dilating the blood vessels of the skin it causes more loss of heat by radiation than its own combustion produces. The fall in temperature is slight, not more than say 1/4 to 1 deg.C., except when the body is exposed to external cold.

(1) Schaefer's Physiology 1900 Vol.1 pp.820 & 821.

From the fact that alcohol dilates the blood vessels of the skin, and so exposes more blood to the external air, it seems probable that it will lead to an increase of temperature in tropical climates.

_____//_____

(1)
 Dogiel found that small quantities of alcohol caused an increase in the rate of respiration in dogs, whilst large quantities caused a decrease. But we may point out that though the respiratory rate be increased the respiration might be so shallow that even less air would pass through the lungs in a given time. Further, in his numerous experiments on soldiers Parkes (2) also noted the effect of alcohol on respiration and concluded that "The respirations were not increased in number by alcohol, they were rather lessened and were deeper in some of the experiments but the effect was not very marked".

(3)
 According to Abel an increase in the amount of air passing into the lungs in a given time may be brought about in several ways; as, 1st. By a stimulating agent acting directly upon the respiratory centre, or, (2) By the agent acting reflexly upon the digestive tract. or, (3) By altered psychical states, or, (4) By changes in the metabolic processes leading to a greater demand for oxygen, or, (5) as a consequence of reflex action directed toward regulating the temperature of the body by a larger exhalation of water vapour.

One naturally asks, does alcohol after absorption act directly upon the cells of the respiratory centre as a primary or specific respiratory stimulant, such as carbon-dioxide? In order to decide this point Loewy endeavoured to estimate the excitability of a respiratory centre whilst it was under the influence of

(1). Physiological Aspects of the Liq. Prob. Vol. 2 Page 97
 (2) Proceedings of the Royal Socy. London. Vol. 22 p 190
 (3) Physilog. Aspects Liq Prob. Vol 2 page 93.
 (4) Cited by Cushny Text Bk of Pharm. 3rd Ed. 1903. p 136

alcohol, by observing how it responded to the stimulus of an increase of carbon dioxide in the blood.

(1).

According to Cushny, these experiments do not lend support to the theory that alcohol increases the irritability of the respiratory centre. So alcohol apparently does not act as a direct central stimulant to respiration.

(2)

Wood, in his summary of the action of alcohol states " The action of small doses upon the respiratory centres is not thoroughly established, but is probably stimulant. Large doses depress the respiratory centres and finally may cause death by centric paralytic asphyxia".

(3)

Abel cites experiments by V. Jaksch on the effect of alcohol on the respiration in children. Eleven children were experimented upon, each one received 11 c.c. of wine, equal to 1.3 grammes of alcohol. Noting the respiration half an hour after the alcohol had been given, the Jaksch found that, respiration rate had been increased in five of them, in five others he found no change in the rate, and in one the respiration was slowed. It is well to note, however, that in these experiments the amount of air actually respired was not measured. The respirations were simply counted, and direct observations were made of the chest movements.

The afore-mentioned experimenters believe that alcohol is a stimulant of the respiratory centre; but Bunge (4) criticising the findings of Binz opines that there must have been a flaw in Binz's work, because alcohol belongs

(1) Text Book of Pharm. Ed. 3 (1903) p.136.

(2) Therapeutics Its Principles & Practice 11th Ed. 1902 page 287.

(3) Phys. Aspects of Liq. Prob. Vol 2. Page 101.

(4) Cited by Abel Phys. Aspects of Liq. Prob. Vol 2 p 102

to a group of substances which are depressant to the central nervous system, and it is therefore not likely to have any marked stimulating action on the respiratory centre.

To test whether Bunge was right in this view
 (1) Binz again had recourse to experiments, and found that even after subcutaneous injection of alcohol--thus avoiding its reflex effects on the stomach-- there was an increase of 69% of air respired by the rabbits experimented upon.

(2) Jaquet agrees with Binz that alcohol well diluted and given in small doses causes the rabbit to breathe more air in a given time, but he does not subscribe to Binz' conclusion that alcohol directly stimulates the respiratory centre. He thinks rather that it is a respiratory stimulant only by reason of its irritant action in the stomach or elsewhere. Jaquet finds that alcoholic solutions of the strength used by Binz produces a bright red colour on the mucous membrane of the stomach of a rabbit, thus giving proof of their irritant action on this tissue. According to Jaquet, alcohol whether injected beneath the skin, or into a vein, or when inhaled into the lungs in the form of vapour, or administered by the stomach leads only to indirect stimulation of the respiratory centre.

(3) Binz and his followers, notably Willmans, then made further experiments, and refuted as they believed, each of Jaquet's conclusions. Still further

(1) Physiological Aspects of The Liquor Problem. Vol 2
 page 102 (cited by Abel)

(2) Ibid. page 104.

(3) Ibid page 105.

experiments were afterwards carried out in the laboratory of Binz, in which alcohol and the volatile constituents of wine, brandy etc, were demonstrated to be respiratory stimulants.

(1)

Wendelstadt, of this laboratory, found that in sixty-four experiments there was an increase of the amount of air respired in thirty-four of them; a decrease in nine, and no change in one. While in twenty-nine experiments with ethyl alcohol a decrease occurred in 7 cases. On the other hand, in 35 experiments with wine a decrease only occurred twice. Wendelstadt observed that the average increase after wine was greater than the average increase after equivalent doses of pure alcohol, and that ethylic alcohol alone had only a very slight effect on non-fatigued persons. He noted, moreover, that when sugar and lemon juice were mixed with alcohol the effect was a greater stimulation of the respiration than when alcohol alone was used. Probably the best explanation of the effects of alcohol and alcoholic beverages upon respiration is that given by Singer,⁽²⁾ one of the latest experimenters in this field of research. Singer concludes that Jaquet had exaggerated the influence of gastric irritation on respiration, and that this reflex irritation could not account for all the increased activity of the respiratory centre. On the other hand, he does not agree with Binz that the increased activity of the respiratory centre is due to direct stimulation by the alcohol, but only to the result of an increased

[1] Cited by Abel Physiological Aspects of the Liquor Problem. Vol.2. Page 105.

(2) Ibid page 110 & 111.

demand for oxygen in the tissues. Alcohol, according to Singer induces the tissues to call for more oxygen, and the respiratory apparatus, responding to this call passes a larger amount of air through the lungs.

Further, it is well known that alcohol dilates the superficial blood vessels thus leading to increased dissipation of heat. The organism counteracts this loss of heat by increased heat production, which in turn, is brought about by an increased supply of oxygen hence an increase in the amount of air respired.

So far as one is able judge from consulting the literature dealing with this subject, he feels inclined to agree with Singer's explanation of the phenomena observed.

THE ACTION OF ALCOHOL & ALCOHOLIC BEVERAGES ON

THE STOMACH AND DIGESTION.

The oft-quoted case of Gastric Fistula in the Canadian hunter Alexis St. Martin probably marks the beginning of direct observation, and forms the basis of exact knowledge of what takes place in the stomach on the introduction of alcohol and various food stuffs.

(1)

Dr. Beaumont, who made numerous experiments and observations on this case stated:- "The free use of ardent spirits, wine, beer, or any of the intoxicating liquors when continued for some days has constantly produced morbid changes.....Nor are these changes indicated by any ordinary symptoms, or particular sensations described or complained of, unless when in considerable excess. They could not, in fact, have been anticipated by any external symptoms, and their existence was only ascertained by ocular demonstrations."

In the stomach, as in the mouth alcohol produces a sensation of warmth. Here again the alcohol acts reflexly, and a very large quantity of spirits taken at a draught produces great depression or even stoppage of the heart.

(2)

Orfila, Percy, and others, have killed animals by passing a large quantity of spirit into the stomach so rapidly that it (the spirit) could not have had time to be absorbed in sufficient amount to produce

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- (1) Quoted by Dr. Hargreaves in prize essay "Alcohol & Science". (1875). p.146.
 (2) Brunton. Disorders of Assimilation, Digestion, &c. 1901 p.82.

death by its poisonous action on the tissues.⁽¹⁾ It must therefore have caused death reflexly. In the stomach also alcohol causes reflex dilatation of the blood vessels, and increased secretion of Gastric Juice.⁽²⁾ Prof. Sims Woodhead states that "the fluid secreted appears under these conditions to be more dilute and less active than is the normal gastric secretion." As opposed to Woodhead's view Chittenden, Mendel, & Jackson, affirm that the acidity and proteolytic power of the gastric juice are increased by moderate doses of alcohol.⁽³⁾

It is believed that alcohol stimulates the movement of the stomach because its administration not infrequently leads to the expulsion of gas.⁽⁴⁾ Hutchinson affirms that alcohol in dietetic doses greatly increases the peristaltic movement of the stomach.

⁽⁵⁾ Binz experimenting on this point introduced 100 c.c. of olive oil into the stomach of each one of a number of adults, whose stomachs had been previously washed out with tepid water. Two hours later the contents of the stomach were removed by the stomach pump. In a number of the cases he commenced to administer brandy immediately after the introduction of the oil, giving eight small tea-spoonfuls at short intervals during the space of an hour. It was found that the brandy increased very considerably the rate at which the olive oil had been passed out of the stomach into the intestines. The activity of the stomach

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- (1) Ridge. "Alcohol & Public Health." 2nd Ed. 1893 p.3.
 (2) Lees & Raper Lecture 1903. p.7.
 (3) Cited by Wood "Therapeutics Its Principles & Practice 11th Ed. 1902. p. 286.
 (4) Food & The Principles of Dietetics. 1902. p. 323
 (5) Lectures on Pharmacology. Trans. New Syd. Soc. 1895. p. 322.

was increased in six experiments by the action of moderate doses of alcohol. Ridge,⁽¹⁾ however, suggests that the occurrence of eructations after the administration of alcohol may be due to relaxation of the cardiac sphincter, brought about by the anti-spasmodic action of alcohol. Indeed, its power of checking vomiting rather indicates that it has a tendency to diminish the movement of the stomach, and he suggests further that the contents of the stomach escape more rapidly into the intestines on account of diminution of the reflex action of the pyloric sphincter, which relaxes earlier than usual, thus allowing the food to pass out of the stomach.

(2)

Hutchinson teaches that when alcohol is present in the digesting mixture to the extent of only 1.2%, its influence on gastric digestion is rather favourable than otherwise. He states⁽³⁾ :- "Immunity of pepsin to the action of alcohol is very striking, and as a consequence of it one cannot regard pepsin wines as irrational products of pharmacy.....the action of alcohol in dietetic doses at least is entirely favourable."

If, however, the proportion of alcohol reaches 5 to 10%, chemical changes are considerably retarded, and they are actually arrested when the proportion reaches 20%.⁽⁴⁾ Brunton cites experiments to show that both wine and beer, even in small quantities, interfere with digestion. Buchner, who conducted these experiments, washed out the stomach by means of a syphon six hours

(1) Alcohol & Public Health. 2nd. Ed. 1893. p. 9.

(2) Food & The Principles of Dietetics. 1902. p. 323

(3) Ibid. p. 323.

(4) Disorders of Assimilation, Digestion, etc. 1901. p. 128.

after a dinner. On one occasion those experimented upon drank water only with the dinner. On another occasion beer or wine. Buchner then drew his conclusions regarding the effect of these drinks upon digestion from the presence or absence of food in the stomach at the expiration of the six hours.

These conclusions accord with the findings
 (1) of Chittenden, viz., that the inhibitory influence of beer and wine upon peptic digestion is greatly out of proportion to the alcohol contained in them. This inhibitory effect is due no doubt to the amount of solids and extractives found in these beverages. In large doses alcohol frequently retards the digestive process, precipitating pepsin and peptones. It diminishes the secretion of gastric juice, promotes the secretion of mucous, and leads to vomiting. (2) Sir William Roberts showed by experiments conducted outside the body that neither wine, beer, nor spirit could promote the conversion of starch into sugar, nor the digestion of albumen, and if the proportion of alcohol exceeded one to two per cent of the digesting mixture these chemical changes were retarded. Brandy and whisky precipitated the starch more rapidly than proof spirit or gin, both the stronger and lighter wines, as sherry and claret, even in dietetic doses and out of all proportion to the amount of alcohol they contained showed a powerful inhibitory effect upon Salivary Digestion. This inhibitory effect was found to be due to a considerable degree of acidity which these wines possessed. Malt liquors also

(1) Physiological Aspects of the Liquor Problem. Vol.1. p.147 1903.

(2) Lectures on Dietetics & Dyspepsia. 1885 pp.24 & 25.

were found to inhibit Salivary Digestion in proportion to the amount of acid they contained.

Summarising these facts, one concludes that alcohol in small doses appears to exercise no influence on the chemical process of digestion. It, however, increases the secretion of saliva and of gastric juice, and probably stimulates the peristaltic movement of the stomach, though one cannot regard the last point as having been conclusively proved, for the expulsion of gas from the stomach, and also the more rapid passage of food stuffs from the stomach to the intestines after imbibition of alcohol, may be explained by its anti-spasmodic and anaesthetic actions. Large doses of alcohol, as all authorities admit, retard or even arrest digestion.

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Schmiedeberg as well as others have proved that alcohol lessens the oxygen carrying power of the blood, and speaking of Harley's experiments he declares,⁽¹⁾ that these prove that alcohol diminishes both the amount of oxygen absorbed and the carbonic acid given off.

Alcohol has also a marked influence on the leucocytes or white corpuscles of the blood interfering considerably with their activity⁽²⁾

⁽³⁾ Prof. Woodhead affirms that the experiments of Massert & Bordet go to shew that alcohol exerts a very active negative chemiotaxis, and appears to be endowed with the property of repelling leucocytes, and if alcohol be circulating with the blood, even in small quantities, the leucocytes work their way into the blood with great difficulty.

Alcohol thus leads to leucopenia or to a diminished number of leucocytes in the blood.⁽⁴⁾ Prof. Woodhead further affirms that there can be little doubt that alcohol interferes with phagocytosis, and also with the power of the leucocytes to manufacture complements.

Alcohol diminishes the alkalinity of the blood as the result of its own oxidation, and the formation of small quantities of acid substances.⁽⁵⁾ It has been found that if the red blood corpuscles of one animal be introduced into the abdominal cavity of an animal of another species, and a drop of blood be taken from the second animal and added to the blood of the first, there is a breaking down of the red blood corpuscles of the first

(1) Brunton. Text Book of Pharm. Therap. & Mat. Med. 1887. p. 72

(2) Dogiel. Cited by Captain O'Gorman. The Scientific Valuation of Alcohol in Health. 1900. p. 18

(3) Lees & Raper Lecture (1903) p. 28.

(4) Ibid p. 32.

(5) Woodhead in Med. Temp. Rev. April 1903 p. 112

animal.

Alcohol seems in some cases to retard this process
of breaking down, in others to accelerate it. (1)

(2)
Prof. Woodhead, speaking of this subject says:-

" As in the case of the production of immunity, so in
" the case of haemolysis, or breaking down of the blood,
the presence of alcohol interferes with the ordinary
"physiological processes, with the result that certain of
"the phenomena that appear when no alcohol is given make
"their appearance when it is administered".

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(1) Woodhead. Lees & Raper Lecture 1903. p.30.

(2) Ibid. p.30.

takes place very slowly, and that an appreciable amount can be found in the blood twenty four hours after being imbibed. Cushny considers that this explains Kraepelin's statement, that the effect of alcohol upon the brain can be detected from 12 to 24 hours after its ingestion.

The method used by Gréhant in these experiments was as follows:-
 (1) The tissue or fluid which he intended to test was distilled in vacuo and the distillate tested by adding a solution of potassium bichromate made acid with sulphuric acid, the bichromate being reduced by the spirit. This test, however, does not distinguish between alcohol itself and certain immediate products which may arise during the oxidation of the alcohol.

(2) Niclaux converted this into a quantitative test by using a standardised bichromate solution, and taking advantage of the fact that a particular change of colour takes place when an excess of the reagent has been added. Niclaux found that the amount of alcohol present in the circulating blood in the earlier hours under its administration was in exact proportion to the amount administered. He also appears to have proved that what was true of the blood was true of the lymph and various fluid secretions of the body, for according to him these contain at any moment a proportion nearly equal to that in the blood. The glandular organs were found to contain amounts not much below that found in the blood.

(3) As has been pointed out by Hopkins, the oxidation, even when it takes place may be only partial, the alcohol not being broken down to its ultimate products,

(1) Cited by Dr Hopkins in Med. Temp. Rev. Oct. 1903 p293

(2) Ibid. pp. 293 & 294.

(3) Cited by Woodhead in Lees & Raper Lecture 1903 p35.

carbonic acid gas and water. " The process of oxidation
 " indeed may be one in which the alcohol is broken down
 " from its toxic condition to one not so injurious to
 "the tissues, though even this process can never go on
 " in the case of a poison, without some damage being
 "inflicted on the tissues in which it occurs. The most
 " injurious toxines or poisons, such as those produced
 "in diphtheria and tetanus, undergo oxidation in the
 "tissues of most warm blooded animals, and it is always
 "difficult to recover such substances from the tissues
 " when once they have been introduced.....Amyl
 " alcohol is oxidised in the body and it is four times
 "as poisonous as ethyl alcohol."
 (1)

(2)
 Dr. Hopkins says:-" Any substance oxidised in the
 "tissue must yield energy to the body, and it might
 "happen that such a substance, though poisonous in
 "large amounts, could in smaller quantities yield its
 "intrinsic energy in such a way as to be useful. It is
 "not an unthinkable proposition that in this sense a
 "substance may be at once a poison and a food. The
 "question is whether, at a certain dose, the toxic
 "action can become sufficiently slight and the yield
 "of energy sufficiently important for the noxious
 "substance to become actually useful."
 (3)

Dr. Goddard points out that laboratory experiments,
 as opposed to those on the living body, teach us that
 alcohol can be oxidised in successive stages into
 acetic aldehyde, acetic acid, finally into carbon di-
 oxide and water, and it is suggested that these may be

(1) Woodhead - Lees & Raper Lecture 1903 page 35.

(2) Ibid.

(3) "Lancet" Octr. 22nd. 1904 page 1133.

the gradations which do actually take place in the living body, and he affirms that the result of recent experiments point to these as the actual stages, except we may assume that the acetates will produce carbonates in the body, just as citrates and tartrates give rise to carbonates in the urine when administered to animals. And he quotes experiments which he affirms prove that alcohol on being oxidised in the body gives rise to the following substances:- acetic aldehyde, alkaline acetates, alkaline carbonates, carbon di-oxide and water.

(1)

The following experiments were undertaken by Dr. Goddard in order to prove that the oxidation of alcohol takes place in the stages just mentioned.

A dog weighing about 12 kilogrammes is purged and subsequently starved for twenty four hours, when 16 grammes of alcohol are administered to it. Then the animal is placed into a respiration chamber of known capacity, and the expired air is collected so long as it exhibits properties other than those of ordinary expired air. The urine passed by the animal during its incarceration is collected and examined. The animal is then killed, and its body examined for all the carbon compounds (except the carbonates) previously mentioned as derived from alcohol. A separate examination is made of the blood and the liver. A second dog of similar weight is then taken, the amount of alcohol administered being double that administered in the preceeding case. The experiment is repeated and the excreted products examined as before. This animal is then killed and

(1) The "Lancet" Octr. 22nd, 1904 Page 1133.

examined. The same methods are pursued with a third animal, the quantity of alcohol administered being double that given in the second instance. The expired air, the urine, the blood, then finally the finely minced body were all most carefully examined and analysed; and considering that great metabolic changes ordinarily take place in the liver, it was decided to examine this organ per se.

The following tables give the results of these experiments.

Table 1. Summary of experimental results showing the average percentage quantities. (1).

Number of Experiments.	Amount of Alcohol given	Alcohol in the expired air.	Aldehyde in the expired air.	Alcohol in the Urine.	Aldehyde in the Urine.	Alcohol in the body.	Aldehyde in the body.	Alcohol and Aldehyde in the blood.
(a) 6	16 grammes	2.15	0	2.89	0	0	0	0
(b) 6	32 grammes	2.23	2.21	2.21	0	a trace	0	0
(c) 6	64 grammes	3.32	3.9	41.1	2.7	2.4	0	1.1

Table II. Showing the non-volatile Carbon Compounds found in the Urine.

Amount of Alcohol given.	Carbonates.	Acetates.
(a) 16 grammes	}	0
(b) 32 grammes.		0
(c) 64 grammes.		4304 grammes
		2.4 grammes

(1) The "Lancet" Octr. 22nd. 1904.p.1136

Summarising, Dr. Goddard expresses the opinion that when large doses of alcohol are taken, 50% of it is excreted from the system unchanged, and in that case it cannot be considered a food in the proper sense of the term. He further considers that if still larger quantities be taken, it is very probable this remark would apply with even greater force. In small doses, however, amounting to say 1/750 part of the body weight of the animal, he found that a little more than 5% of the alcohol was excreted, unchanged. He concludes that nearly 95% is made use of as food.

This conclusion is closely allied to the one arrived at by Atwater. Still whilst admitting investigators have proved that alcohol is to a large extent oxidized in the body, one cannot allow that this oxidation per se proves alcohol to be a food.

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(1) The "Lancet" Octr. 22nd. 1904. Page 1136.

IS ALCOHOL A FOOD?
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In treating of the effects of alcohol one is met at every turn with diversity of opinion, indeed, one may say with directly opposite opinions on many points. But probably on no one point have differences of opinion and heat on controversy been more marked, or waged more fiercely, than on the question now under consideration.

No doubt, this is in part explained by the difficulty of defining correctly what constitutes a food. Various definitions have from time to time been attempted. Prof. Bunge states:⁽¹⁾- "We know that alcohol "is to a very great extent oxidised in the body, only "a small part is excreted unchanged by the kidneys and "lungs. Alcohol is therefore without doubt a source "of energy when absorbed into the body, but it does not "therefore follow that it is a food. To prove this it "would be necessary to show that the energy liberated " by the oxidation of alcohol, is used to aid the perform- "ance of the normal functions. It is not enough that "chemical potential energy is transformed into kinetic "energy, the transformation must occur at the right "time and in the right place, and in definite parts "of the tissues. The tissues are not so constituted "that they can be fed with any and every combustible " material.....whilst on the one hand the alcohol

(1) Physiological and Pathological Chemistry. Trans. from 4th. German edition. 1902 p. 117

increases the production, on the other, it increases the loss of heat."

(1)
Dr. Drysdale defines food as :- " A substance "which when introduced into the economy is first of "all assimilated, oxidized, and productive of an effect " in warming the body or giving force to it; and which "is indispensable to the maintenance of life. It is "necessary also that the products of such substance "should be capable of deposition in the system so as to "form a provision which may be used, and which is not "hurtful."

(2)
Dr Ridge speaks of foods as " those substances which "can be taken in a reasonable quantity without risk or " fear and which can be used up in the body, without " any hindrance or disturbance to natural functions."

(3)
Or again:-" food is any substance which will when "absorbed into the blood, nourish the body, repair "waste and furnish force or heat without injuring any "of its parts", and yet again, he says" Physiologists (4)
" have become increasingly certain that no substance " can act as food unless it can enter into beneficial "combination with the cells of the living tissue".

(5)
Prof. Woodhead remarks:-" Alcohol is said to be a "food because eminent chemists tell us it can be "oxidised, but it has been pointed out that some of the "substances which are most readily oxidized are the most virulent poisons. Alcohol is a poison, it acts as

(1) Med. Temp. Rev. April 1901. p.75.

(2) Ibid June 1901. p.133.

(3) Ibid August 1903. p.228

(4) Ibid June 1901. P. 132.

(5) Ibid August 1902. P.323.

"a poison, it is oxidized as a poison.....It
 "is not a food because it contains certain elements
 "that are necessary for the building up of our body.
 "It is only when these are in proper form that they do
 "not in any way act as poisonous substances". These
 definitions would exclude alcohol from the category of
 foods.

(1)

On the other hand Dr. Goddard summarising his
 experiments on alcoholized dogs, says:-" Since no alde-
 " hyde or other alcohol derivatives are found in the
 " expired air, in the urine, in the blood, or in any
 "part of the body of the animal after death, we may
 "conclude that the remainder, nearly 95%, is made use of
 " as a food".

(2)

Prof. Atwater after most carefully conducted
 experiments states:-" 1st. Taken in moderate quantities
 " alcohol is oxidised in the body as completely as ordinary
 "food materials. 2nd. The latent energy of the alcohol
 " was transformed into heat and muscular work. 3rd. The
 "alcohol protected the material of the body from consumpt-
 "ion just as effectively as the corresponding amount of
 " sugar, starch and fat. He further states:- 1st" We
 "ought not on the one hand to teach that alcohol is a

(1) The "Lancet" Octr. 22nd. 1904. p. 1136.

(2) Physiol. Aspects of the Liq. Problem. 1903 p. 289.

(3) "Harper's Monthly" Mag. Octr. 1900 p. 680.

(4) Quoted by Prof. Herter "From a slip published Nov. 6th.
 1899 by the United States Dept. of Agriculture",
 In the pamphlet - An Appeal to Truth - p. 16.

(5) Quoted by Ridge in Med. Temp. Rev. April 1903
 pages 101 & 102.

food in the common sense of the word, and on the
 " other we cannot discuss its physiological action
 "thoroughly without recognising its nutritive value, but
 "we must point out its limits". Secondly, " we ought
 "not to declare that alcohol is a poison in the common
 "sense of the word. In large quantity alcohol is poison-
 "ous, In sufficiently large amount it is deadly. In
 "small quantities taken day after day it ruins the body
 "and the mind. Its effects vary according to the
 "individual and the circumstance, but it is not true
 "that alcohol in small quantity in a dilute form, such
 "as is the case with ordinary alcoholic beverages is a
 "poison".

(1)

Sir Lauder Brunton says:-" The question
 "whether alcohol is a food or not has given rise to
 "very great discussion and has been debated very hotly.
 " If we examine the question dispassionately, we shall
 "probably come to the conclusion that alcohol is a food,
 "although for healthy persons it is not a convenient food!"
 Then he proceeds to compare(the merits of combustion of)
 alcohol with those of sugar, and continuing⁽²⁾ says:- "Alcohol
 "undergoes combustion in the body but at the same time
 "it tends to lessen the combustion of other things. In
 "healthy people this is of course a disadvantage, because
 "it is by combustion of our food that our strength is
 " maintained. Alcohol is therefore for healthy people
 " a very inconvenient form of food."

(3)

Hutchinson expresses a similar view, and
 (4) Cushny states:-" In undergoing combustion alcohol gives
 " up energy to the body, and therefore is technically a

(1) Disorders of Assimilation, Digestion, &c. 1901. p77

(2) Ibid page 79

(3) Food & The principles of Dietetics. 1902 p. 329.

(4) Text book of Pharm. 3rd Ed. 1903. p 42.

food".

Ever since the days of J.von Liebig (1858) this dispute as to whether alcohol is a food or not has continued with more or less heat. Liebig declared alcohol to be a food, and classified it amongst the carbo-hydrates. Alcohol was spoken of as a "respiratory" food, and this view was held for many years by some of our ablest physicians as Todd, Stokes, Graves &c.

Especially was alcohol believed in and relied upon as a suitable food for patients suffering from fevers. Dr.

(1)
Todd prescribed 1oz of brandy each hour in a case of
(2)
continued fever, and gave as much as 48 oz. of brandy per day to a girl of 18 years, suffering with pneumonia and enteric fever.

In 1860 the three French chemists Lallemand, Perrin, and Duroy performed a number of experiments which they declared proved that alcohol left the body unchanged, passing away chiefly by the urine, and they affirmed that Liebig's theory of alcohol being a food was disproved by these experiments.

Later Binz, Anstie, and others demonstrated that when alcohol was given in very small quantities, a portion of it was oxidised and used by the body, and all recent experimenters agree that this is the case.

The facts seem to be as follows:- Alcohol can only be spoken of as a food in the most technical sense of that term, even if it can be so described at all. About 95% of small or moderate doses is evidently oxidized in the body, but this oxidation scarcely seems to take place

(1) Clinical Lectures 2nd Ed. 1861. Case 38. P.145.

(2) Ibid....pages 122 to 125.

as does that of a food, for we have seen that in small doses alcohol will remain two to five hours in the blood undergoing little change, and in some cases will remain unaltered for four or five hours, after which time it seems to undergo rapid oxidation, and to disappear quickly between the fourth and seventh hours. The manner of its oxidation would suggest its being a toxic substance, indeed, as has been pointed out before, Prof. Woodhead states:⁽¹⁾ "It is oxidised as a poison". Further, quite a number of substances such as the higher alcohols, the aldehydes, ethers, alkaloids and toxins are oxidized in the body, but we cannot therefore argue that they are foods in any proper sense of the term. These substances during their oxidation must produce heat, but we do not therefore attempt to prove that they are foods. Then too, alcohol is known to cause loss of heat by dilating the blood vessels of the skin and stimulating the sweat glands, so that even on this count, it may lead to the loss of as much heat as, or even more than, it produces.

Again, its poisonous effect on protoplasm generally and its paralysing influence on the cells of the body, together with its interference with production of immunity, all suggest its being a toxic substance and not a food. Alcohol has been spoken of as a "respiratory food" and compared with sugar. But although sugar and alcohol are composed of the same chemical constituents, their characteristic actions upon the body are very different indeed. Experiments have been resorted to with the object of deciding whether alcohol can take the place

(1) Med. Temp Rev. August 1902 P. 232

(1)
of a carbo-hydrate or not. A French naturalist, Chauveaux, conducted the following experiments. He fed a dog during several weeks with a weighed amount of meat and sugar each day, and caused him to run for two hours on a tread-mill. The dog appeared to cover 20 Kilometres with ease each time. He even increased in weight. A third of the sugar was now stopped and replaced by an equivalent amount of alcohol, the meat food being given in the same quantity as before. In this case, although the dog was lively he could not be induced to cover more than 17 kilometres on the tread-mill. Evidently there was less working power when alcohol was given, and in every instance the dog showed a loss of weight when taking the alcohol.

(2)
Further Dr. Hopkins points out that if all the heat that alcohol can possibly give were utilized, there would still be a waste of 15% of the energy that was contained in the sugar from which the alcohol was derived.

(3)
On the other hand, Sir Lauder Brunton contends that although alcohol is not a convenient food for a healthy person yet in cases of fever "it may be a very "useful food"....."because there the body is "burning away too rapidly, and alcohol has a double "advantage of retarding this process, as well as acting "itself as a food". Brunton further states " Hammond (4)
"found that when on insufficient diet he was losing "weight, the addition of a little alcohol not only enabled " to reach his former weight but to add to it". Others

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- (1) Cited in Med. Temp. Rev. Octr. 1902 page 304. (by Kellogg)
(2) Cited by Prof. Woodhead in Lees & Raper Lect. 1903 p32
(3) Disorders of Assim. Digestn etc. 1901. p 79
(4) Text Book of Pharm. Therap & Mat. Med. 3rd. Ed. 1887 p768.

believe it to be very useful in old age if not
absolutely necessary, and speak of it as "the milk of
old age".

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IS ALCOHOL A FOOD SPARER.?
 =====

Even if alcohol is not itself a food it may still be asked, is it a sparer of other foods? Prof. Atwater⁽¹⁾ holds that it is, and expresses himself on this subject as follows:- "The alcohol protected the material of the body from consumption just as effectively as the corresponding amount of sugar, starch and fat". But at a later date (Octr 1903)⁽²⁾, he expresses himself as follows:- "The testimony of the experiments now available is, on the whole, to the effect that alcohol resembles fats and carbo-hydrates in the protection of fat from consumption, but is inferior to them as a protector of protein. It is true of alcohol as of fats and carbo-hydrates, that it sometimes protects protein.....Alcohol has some specific though unexplained action by which it may increase the metabolism of nitrogen." While later still 1903⁽³⁾, he states, 1st. Alcohol may, and does, protect body protein. 2nd. Alcohol sometimes fails to protect body protein.....3rd. "As regards efficiency for protecting protein, the carbo-hydrates, fats and alcohol rank in the order named".

⁽⁴⁾ Binz teaches that when there is a proper supply of carbo-hydrate or of other oxidisable substances, the waste of albumen taking place in the body is but slight. He further teaches that the normal quantity of the final products of that waste as found in the urine is diminished when moderate doses of alcohol are taken. Continuing he affirms that upon this point all investigators

(1). Quoted by Prof. Herter from a slip published Nov 6th/99 by the U.S.A. Dept of Agriculture in the pamphlet An Appeal to Truth. page 16. (2) Harper's month Mag. p684.
 (3). Physlg. Aspects of Liq Prob. 1903. Vol 2. p 305.
 (4) Lects. on Pharm. Trans New Syd Soc. 1895 p 329.

agree, there having been less diversity of opinion than upon any other point concerning the pharmacological action of alcohol.

(1)
Hutchinson after noting the effect that alcohol partially paralyses the sense of the body with which it comes in contact, remarks that the cell, in consequence of the paralytic action, will lose some of its power of breaking down compounds such as fats and carbo-hydrates-
"Alcohol"- then says he " saves fat from combustion, in other words is a fat sparer. It also appears, though with great difficulty, to be able to spare carbo-hydrate, but it is exceedingly doubtful whether it is ever able to so far paralyse the cell as to destroy its power of dealing with proteid".

(2)
Cushney after quoting a number of experiments, affirms these investigations show that alcohol can take the place of some of the fat in our food and that it leads to the same economy of proteid substances as do the ordinary non-nitrogenous foods. For though during the first three or four days of the period when alcohol was taken in the place of fat, the alcohol showed little or no tendency to economise proteids, he states " This is true of other forms of food also, any sudden change in the non-nitrogenous food leading to a temporary increase in the nitrogen excreted", which increase lasts till the tissues have become accustomed to the new dietary.

(3)
On the other hand Dr. Hopkins affirms that Atwater's

(1) Food & the Principles of Dietetics. 1902. p 328.

(2) Text book of Pharm. 3rd Ed. 1903. p 144.

(3) Cited by Prof. Woodhead in Lees & Raper Lecture 1903 page 38.

experiments do not prove conclusively that alcohol is a proteid sparer, and he states" Even when there is no disturbance of the nitrogen balance there may be marked alteration in the nature of the nutritive processes, as evidenced by the observation of Rosenfeld and Chotzen that in the equilibrium obtained during the administration of alcohol there is excretion of uric acid;and that this appearance of an increased amount of uric acid indicates increased tissue changes".

(1)

And Bunge affirms that the latest and most accurate researches on the effects of alcohol on man" have failed to show any economy of proteid as the result of the injection of alcohol", and he quotes experiments conducted by Miura. This gentleman(Miura) first brought himself into a condition of nitrogenous equilibrium by means of a diet including fat and carb^o-hydrates, then he replaced for a few days a portion of the carbo-hydrate by its equivalent of alcohol. On those days when he was taking alcohol, he found that there was a rise in the excretion of nitrogen as great as on other days when a portion of the carb^ohydrate was omitted without taking any corresponding food in its place. Miura was therefore lead to the conclusion that alcohol did not spare proteid disintegration, and that it could not replace carb^ohydrate as a sparer of proteid.

Further, some authorities believe that even if alcohol is not a proteid sparer in conditions of health, it nevertheless checks the rapid waste of nitrogenous

(1) Text Book of Phsiol. & Pathol. Chemistry trans from 4th German Ed. 1902. page120.

tissue which ordinarily takes place in fevers; anent
(1)
which Hutchinson remarks:-" Unless however, the behaviour
of alcohol is very different in fever than its action
under healthy conditions, a proposition for which there
is no real evidence, one is not justified in assuming
that it has any appreciable influence in that direction"

Alcohol in small and moderate doses does not
appear to have any power to diminish nitrogenous
waste, while in large doses it actually increases
such waste. Nor is it definitely proved that alcohol
can act as a sparer of fats or carbo-hydrates.

(1) Food & The Principles of Dietetics. 1902. p 328

THE ACTION OF ALCOHOL ON THE VOLUNTARY MUSCLES.

The dynamometer shows that alcohol in dietetic doses gives rise to temporary stimulation of the muscular system. But Mosso's ergograph probably gives more satisfactory results than the dynamometer. In this ergograph a special arrangement prevents the action of any other muscle than those which bend the middle finger of the hand. By means of a small cord passed around a pulley the finger raises vertically a weight. To the cord is attached a needle, which records on a dial the height to which the weight has been raised. The person experimented upon is made to raise a weight of four or five kilogrammes about every two seconds, and this procedure is continued for a definite period of time. When alcohol is given in small doses, $1\frac{1}{2}$ to 5 drachms of a 90% solution, the work is increased for about 15 minutes, after which time the paralysing effect of the alcohol is seen.

(1)
Destree after numerous experiments stated: "The precise moment when the paralysing effect of alcohol becomes manifest varies slightly with the subject, but it is noticeable in the majority of cases in ten minutes after the alcohol has been given. This effect becomes more and more marked till the maximum is reached, usually twenty of thirty minutes after the alcohol has been taken".

The total output of work is less (that is, if the experiment be continued long enough) when alcohol is used than when it is not used.

In proof of this Destree ⁽²⁾ cites the following

(1). Med. Tem. Rev. April 1899 page 80.

(2) Ibid pp. 81 & 82.

experiments:- A certain doctor aged 28 made a number of trials on himself with the following results... During the first day for a group of six series^{of trials} with an interval of two minutes rest between each series, the work done amounted to a total of 14.075 kilogrammetres. He then rested half an hour, afterwards proceeding with the second group. There were six series again, and the total of this group amounted to 8.255 kilogrammetres. The two groups gave a grand total of 22.330 kilogrammetres of work done without alcohol. The same experiments were repeated the next day by the same gentleman, under exactly the same conditions, except that he took 20 grammes of alcohol immediately before commencing them. In this case the first series^e showed an increase of nearly one kilogrammetre (0.930) over the first series of the preceeding day. But immediately afterwards the reaction set in, and all the other series were lower than the corresponding ones of the preceeding day. The grand total on the alcohol day amounted to 15.935 kilogrammetres^{re}, representing a loss of work as compared with the previous (non-alcoholic) day of 6.935 kilogrammetres. Destree⁽¹⁾ sums up this subject as follows:-

- "1. Alcohol has a favourable effect on the work product, whether the muscle is weary or not."
- "2. This favourable effect appears almost immediately but is very transitory".
- "3. Immediately afterward alcohol has a very decided paralysing effect." About half an hour after taking alcohol the muscular power reaches a maximum that subsequent doses increase with difficulty".

(1). Med. Temp. Rev. April 1899. Page 83.

4. " The subsequent paralyzing effect of alcohol outweighs the momentary stimulation, and the total work product obtained with the use of alcohol is less than that obtained without it."

(1)

Prof. Abel suggests that these Ergograph experiments are vitiated somewhat by the fact, 1st. that the apparatus used was not kept out of sight of the person experimented upon, 2nd. that the taste of the alcohol was not disguised, 3rd. that no control experiments were carried out, that is, in the way of giving a drink tasting like the alcoholic beverage used but not containing any alcohol.

Similar results to those of Destree were obtained by Parkes during the Ashantee War from experiments made on soldiers while marching, and Sir Victor Horsley, having spoken of certain of Kraepelin's experiments on this point, adds " the conclusion therefore seems overwhelming that even in very small quantities - that is to say in dietetic amounts- alcohol had an injurious effect on muscular work".

Frey, however, had come to rather different conclusions as to the effect on alcohol on "unwearied" muscle, he having satisfied himself that alcohol had only a paralyzing effect upon such, but as Destree points out, Frey only commenced to exercise the muscle 10 or 20 minutes after the administration of alcohol, at which time the stimulant effect would be passing, or would have passed away.

(1) Physiological Aspects of the Liquor Problem. 1903 pl48

(2) Cited by Capt. P.W.O'Gorman in The Scientific Valuation of Alcohol in Health p.26

(3) The "Lancet". Report of Lees & Raper Lecture Vol.1 1900.

After reading of many of the experiments conducted in this field of research, one feels satisfied that Destrée's "findings" are conclusive.

THE EFFECTS OF ALCOHOL ON THE NERVOUS SYSTEM.

The effects of alcohol are probably more marked on the nervous system than on any other part of the body. Even its action upon the cardio-vascular mechanism is exerted largely through the nervous system. It was seen in the section dealing with the "isolated" heart, that alcohol in moderate doses had little or no effect upon that organ when separated from the central nervous system. It has been shewn too, that much, if not all, of the increase in the pulse rate observed after the administration of alcohol is produced reflexly through the nervous system ere the alcohol has had time to be absorbed by the stomach and intestines. Many of the pathological effects of alcohol display themselves in the nervous system, as the gradual paralysis of the higher cerebral tissue manifesting itself by the loss of the mental faculties in the inverse order of their developement.

Some authorities as De Boeck, Dietl & Vintschgau for instance, say that the paralytic action of alcohol is preceded by a temporary stimulation. De Boeck states "in reality alcohol must be considered as a paralyzing agent, but the state of paralysis is preceded, whatever be the mode of activity which we look upon, by a state of stimulation". Dietl and Vintschgau experimented with wine in order to determine the duration of the mental reaction under its influence. They showed that when the dose of wine was not too large it produced

(1). Med. Temp. Rev. March 1901 page 56.

(2). Cited by Abel Physiological Aspects of the Liquor Problem 1903. Vol. 2 Page 121 & 122.

primary acceleration of the mental processes.

(1).

Rose Bradford states " Alcohol like most stimulants has a double effect. The increased functional activity caused by it is followed by a period of diminished activity or depression. Further, alcohol, like most other drugs, acts on the higher functions first, and so both the stimulating and the paralysing action of the drug show themselves first on the highest cerebral centres".

(2)

(3)

Others as Schmiedeberg and Bunge declare that the paralytic action of alcohol is immediate. The former holds strongly to the view that the action of alcohol on the nervous system is that of a paralysing agent and certainly not stimulant in any true sense. Whilst

(3)

Bunge states "Alcohol has invariably a paralysing influence. All the results which on superficial observation appear to show that alcohol possesses stimulant properties can be explained on the ground that they are due to paralysis.....The stimulating action which alcohol appears to exert upon the psychical functions is also only a paralytic action".

(4)

Warren made a large number of observations administering moderate doses of alcohol in very dilute solution. In three cases he noticed a pronounced acceleration of the mental processes, and in one case, a long retardation.

(5)

Sir Lauder Brunton seems to be undecided whether there is a primary stimulation of the mental faculties or

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- (1) In Hale White's Pharmacology 1901. page 109.
 (2) Cited by Cushny in Text Book of Pharm. 1903 3rd Ed. p135.
 (3) Text Bk. of Physiological and Pathol. Chemistry. Trans. from 4th German Edition. 1902. pages 117 & 118.
 (4) Med. Temp. Rev. April 1901. p. 83.
 (5) Disorders of Assimilation, Digestion, &c. 1901. pp92.

not, for we find him stating " It is possible that the function of the various parts of the brain is somewhat increased by the direct action of the alcohol upon them, when it is carried to them by the blood, and that this increase is a-part from the greater supply of blood which they obtain from the freer circulation, but such an increase, if it exists at all is in all probability both slight and temporary, and is succeeded by weakened power and finally by paralysis".

(1)

Kraepelin holds that the motor processes are facilitated at first by alcohol especially by small doses. Psychological processes he never found accelerated even in the initial stage. "In other words, alcohol, according to Kraepelin exerts a "stimulating" action on the organ of the mind when it is occupied with sensory-intellectual material, but has a depressent action when the mind is engaged in purely receptive or constructive operations. Larger quantities of alcohol, say the equivalent of a bottle of ordinary wine, depress every type of psychological energy from the very first".

It is accepted as a general principle that alcohol paralyses all forms of protoplasm, but it is well known that it paralyses most readily that which is most highly developed or differentiated; and again, even those who contend for a preliminary stimulation of psychic activity readily admit that this stimulation is of shorter and shorter duration as it affects higher and still higher powers. Hence it is found that the highest functions of the brain are the first to suffer

(1) Cited by Abel in *Physiol. Aspects of Liq. Prob.* Vol. 2. p124&5

from this paralysing action, the several parts of the nerve centres being paralysed in the inverse order of their developement. The most complex function, that is, the latest developed, is the first to suffer.

Although this progressive paralysis varies to a certain extent in different individuals and also with variety of the alcoholic beverage employed, the usual order in which it takes place is as follows:-
Loss of judgment and reasoning powers, then will power and self-restraint disappear, later the power of perceiving relationship to external circumstances is lost.

(1)

On this point Rose Bradford says:- " The action of alcohol in this respect is very similar to the effects produced in the early stages of certain forms of insanity, and more especially in general paralysis, where the grandiose ideas and the difficulty of speech, to mention only some points of resemblance, are strikingly similar to what is seen in certain stages of alcoholic intoxication!" Indeed, alcoholic intoxication has been used by Maudsley and Mercier to illustrate insanity, and both these authorities teach that drunkenness is not merely analagous to insanity but is itself a brief insanity. Maudsley states " Alcohol yields us in its direct effects the abstract and brief chronicle of the course of mania. At first there is an agreeable excitement, a lively flow of ideas.....then there follows in the next stage of its increasing action as there does

(1) Hale White's Pharm. 1901 page 110.

(2) Body & Mind. 2nd. Ed. 1873 pp. 104 & 105.

(3) Sanity & Insanity. 1890. page 314.

in mania, the automatic excitation of ideas which start up and follow one another without order, so that thought and speech are more or less incoherent while passion is easily excited. After this stage has lasted for a time, in some longer, in others shorter, it passes into one of depression and maudling melancholy, just as mania sometimes passes into melacholia, or convulsion into paralysis, and the last stage of all is one of stupor and dementia."

(1)

Mercier affirms "It must be understood that in speaking of alcoholic intoxication as a form of insanity, the expression is not used as a figure of speech. It is strictly and literally true that when, and in so far as, a man is intoxicated by alcohol, then and to that extent, he is insane."

Further, the frequent use of even moderate doses of alcohol induces premature senility of the mental faculties, causing their too early undoing in the inverse order of their development. In this same order (as we have seen) they are undone in acute alcoholic intoxication, insanity and old age. This order of suppression of the faculties by alcohol follows the "law of dissolution" of the faculties in old age.

(2)

Dr Haywood Smith speaking of the law of dissolution says:- "When a drug affects functions progressively, those first affected are the highest in development, the next affected are those next the highest and so on till finally

(1). Sanity & Insanity. 1890 page 314.

(2) Med. Temp. Revw. June 1901. page 137.

the lowest of all, from an evolutionary point of view, the functions of respiration and circulation are affected. Thus the power of judgement is abolished very early by alcohol; this is so while the imagination, the emotions, and the power of speech remain stimulated; but soon the power of imagination goes, the patient loses all command over his emotions, he cries and laughs irregularly, but this soon stops. He next begins to lose control over his speech, talking incoherently and thickly, shortly afterwards he cannot talk at all, he can only make a noise. Muscular movements, which are not so highly developed as those of speech, are next affected, delicate lately developed movements are soon paralysed, then movements depending on co-ordination are affected, and finally stop. Next the activity of the reflex centres of the spinal cord is abolished, and the sphincters are relaxed. Then the respiratory centre, which was previously stimulated, becomes paralyzed, breathing is difficult and the face becomes livid. Lastly the heart, which was also at first stimulated, is paralysed and the patient dies".

A person under the influence of alcohol is deceived concerning the quality of the work he performs, and also with regard to the time taken to perform that work. He thinks he is executing better work, and doing it more quickly and easily than proves to be the case. For example., authors writing under the influence of alcohol have imagined their ideas to be flowing freely and their

language to be exquisite, yet when the influence of the alcohol had passed away they found the work to be most common-place. In the experiments made by Kraepelin and others for testing "reaction time" it was shown that certain mental processes were slowed by even moderate doses of alcohol, yet the person experimented upon believed that he had been working more quickly. Or again Dr. Rose Bradford ⁽²⁾ says:- " The increase in the activity in certain nervous centres may be in part real but it is in part apparent only, the person under the influence of even non-toxic doses imagines that he is capable of ideas and actions which he is really incapable of effecting." The paralysis we have been describing as taking place in the mental faculties may be temporary, as in the case of a single acute intoxication produced by imbibing large doses of alcohol, or it may be permanent, as the result of repeated intoxications, or as the result of small doses frequently repeated for a protracted period.

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(1). Cited by Abel Phys.Aspects of the Liquor Problem
1903 Vol 2 page 125.

(2) Hale White's Text Book of Pharmcy & Therap.1901
page 110.

(1)
and cites Dubois as teaching that "inebriation is credited with a marked influence upon the products of concèption, individuals conceived during acute alcoholism being often degenerate, and Féré has succeeded in producing monsters by the influence of alcoholic vapour on eggs".

(1) Encycl. Medica page 119.

EFFECTS OF ALCOHOL ON SOME OF THE LOWER FORMS OF LIFE

Alcohol appears to be harmful to many, if not all,
 (1)
 of the lower forms of life. Dr. Ridge found that when he "watered" a geranium with a solution of alcohol and water containing but one part of alcohol in a hundred, the geranium was very much stunted in its growth, and that after six weeks time it was not more than half the size of one that had been cut from the same plant at the same time. To begin with both cuttings were equal in size, were placed under the same conditions, and treated in exactly the same way, except that one was "watered" with alcohol as just mentioned, the other with water alone.
 (2)

Richardson found that the medusa was killed by a solution containing one part of alcohol in four thousand parts of water, and Ridge found that with even weaker solutions than this the dephina pulex could be rapidly killed.
 (3)
 Prof. Woodhead mentions experiments by Rauber, who tested the effect of various strengths of alcoholic solutions upon numerous plants, and also upon certain animals in different stages of development. He generally used a 10% solution and found that alcohol acted as a protoplasmic poison to all forms of cell life upon which he experimented:-such as the geranium, nettle, larch, begonia, potato etc. The animals included the hydra, tapeworm, earthworm, leech, crayfish, perch, sparrow, man and other mammals. He found that even a 2% solution of alcohol would kill many of the above named organisms.

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- (1) Alcohol & Public Health. page 25.
 (2) Alcohol & Public Health. pages 25 & 26. Cited by Ridge
 (3) Lees & Raper Lecture. 1903. page 3.

MORBID CHANGES IN THE TISSUES, BROUGHT ABOUT BY ALCOHOL.

As experiments have not been markedly successful in producing anatomical changes akin to those claimed by many authorities to be the result of frequent imbibition of alcohol, there are not wanting those who dispute the power of alcohol to produce pathological lesions to the extent claimed. Still, most pathologists agree that alcohol habitually produces fatty and fibroid degeneration of, and calcareous deposit in various tissues of the body. These degenerative changes are in part caused by the irritant action of alcohol, in part by the malnutrition which alcohol brings about, and are generally associated with oft repeated long continued indulgences. The "indulgences" need not imply intoxication in the ordinary sense, for almost the smallest quantity if frequently repeated is sufficient to induce morbid changes. The principal change is of the nature of fatty degeneration, and is associated with malnutrition. This fatty degeneration affects various tissues as, glandular cells, muscle fibres, and blood vessels. Following upon the fatty degeneration, especially in elderly people, there is a tendency to the deposition of calcareous matter more particularly in the muscular wall of the blood vessels. This deposition of lime salt produces in some cases a cast of the vessel.

(1)

Prof. Woodhead speaking of experiments carried out by himself and Robert Irving F.C.S, anent the secretion and deposition of carbonate of lime in and by animal

(1) Proceedings of the Roy. Socy. Edin., Vol. 16. 1888-9
page 320.

(1) tissues says:- " When alkaline phosphates associated with lime and albumen preponderate in the blood, the lime so separated is in the form of phosphate, as in bone formation; when these are partially replaced by an excess of alkaline carbonates as in marine animals, the lime is secreted as carbonate..... (2) lime salts of whatever form are deposited only in vitaly inactive tissues. They are found in bone matrix, in chitin, in old fibrous tissue(?), or in tissues that have undergone fatty or caseous degeneration". It is found that the alkalinity of the ash of blood is slightly increased (3) after taking alcohol, as is also the proportion of carbonic acid. Given then these conditions of the blood, and a lowered or degenerated condition of tissue, and the necessary factors for the deposition of lime salt are present. Prof. Woodhead (4) further says:-" These fatty and calcareous changes are however, associated with a second series, an increased formation of fibrous tissue in certain active tissues and organs. In some cases this fibrous tissue appears to be formed almost independently of the above described changes, and in certain cases of cirrhosis of the liver the alcohol, taken into the portal vein appears to act first directly upon the fibrous tissue immediately

(1) . Proceedings Roy.Soc Edin. Vol.16.1888-9 . p 352

(2) Ibid page 351.

(3) Med. Temp. Revw. Febry.1903 page 40.

(4) The "Practitioner"-Alcoholic Number- Nov 1902.pages 543-4

⊠ Prof Woodhead here refers to fatty and calcareous changes.

"surrounding the veins where, by a process of direct stimulation or irritation it causes proliferation of the delicate connective tissue cells in the portal spaces, the tissues at first cellular gradually becoming fully formed fibrous tissue, which may extend regularly and steadily until a large portion of the liver substance is destroyed, the fibrous tissue contracting and giving rise to the well known 'gin drinker's liver'. At one time it was accepted that this gin drinker's liver was the typical alcoholic liver; but now-a-days one is driven to the conclusion that a fatty liver in which there is some slight infiltration of the liver cells of the peripheral zone of the lobules, accompanied often by a marked degeneration of the liver cells of the inner zones, with sometimes a more or less marked cirrhotic condition is the more typical alcoholic condition. In certain cases then, the fibrous change must be regarded as being of primary origin, that is, as the result of direct irritation of the connective tissue cells by the alcohol brought to the portal circulation directly from the stomach; but a more common history of the fibrous condition, especially where it is not particularly well marked, is that it is a more or less secondary process associated with the occurrence of the fatty degeneration above referred to." The irritant action of alcohol affects chiefly the stomach, liver, heart, brain and blood vessels, that is, those organs which are directly exposed to the action of the poison. The nervous tissues are particularly sensitive to its action, especially the cellular elements of the most

highly developed portion of the cerebrum. The irritant action of alcohol is seen in the pharyngitis oesophagitis and congestion of the stomach found in chronic alcoholics. In these chronic cases there is often thickening of the mucous membrane with some fibrosis, if the subject be addicted to ardent spirits, whilst, on the other hand, if addicted to beer drinking, dilatation of the stomach is likely to ensue. The liver being the first organ through which the blood circulates after leaving the stomach is subjected to the full action of the alcohol ere it has been diluted, or has had time to be in part oxidised; and as might be expected the liver exhibits the typical morbid changes which habitual indulgence in alcohol produces. The cells of this organ undergo fatty degeneration, which may or may not be associated with fatty infiltration, whilst the interstitial tissue suffers from fibroid degeneration with increase of leucocytes along the small portal veins, and proliferation of connective tissue cells. The normal fibrous stroma is greatly increased in amount, which increase ultimately leads to pressure upon the venules and atrophy of the liver cells. Fatty degeneration of the muscle of the heart also is a common result of alcoholic poisoning, and (1) Graham Steell describes under the title of "Alcoholic Heart" a condition in which this organ is considerably hypertrophied as well as dilated, though the kidneys of the same case are not granular but large and congested. (2) Dr. Cowan teaches that fatty infiltration of the heart

(1) Cited in Encyc. Medica Vol. I. 1889 page 120.

(2) "Fatty Degeneration of the Myocardium", in The Journal of Pathology & Bacteriology. Vol. 8 June 1902. pp. 178-9

"usually accompanies deposition of fat on the surface, though in certain cases there may be an increase in the amount of fat lying between the bundles of the muscle fibres without much increase occurring in the external fat." "This infiltration is," Dr. Cowan affirms, "more marked on the right side of the heart than on the left, and in the auricular than in the ventricular walls. Fatty degeneration differs from fatty infiltration in that it occurs most frequently and most severely in the left ventricle, the muscoli papillares, the adjacent muscle on the posterior wall, and the septum ventriculorum, whilst on the right side the papillae and the muscle of the posterior wall are the common sites." Prof. Sims (1) Woodhead declares that the most recent investigators on fatty heart have come to the conclusion that in this organ as in the liver, the two conditions of degeneration and infiltration are often associated, though either may occur without the other being present. The alcoholic heart and liver present appearances identical with the appearances of these organs when acted upon by other poisons such as phosphorous and arsenic, or with their appearance when acted upon by the products of pathogenic bacteria. The blood vessels undergo distinct fibroid change which consists chiefly of a marked increase in the amount of fibrous tissue in the walls of the vessels; this condition being often associated with the fatty degeneration already mentioned.

(1) Med. Temp. Revw. Febry. 1903. page 36.

(1)

Prof. Woodhead also claims that alcohol acts as a cumulative poison, not only as regards itself but also as regards other poisons, (as arsenic, phosphorus, and antimony), likewise with the products of pathogenic organisms and even with the waste products of ordinary metabolism. With regard to the last point, he affirms that alcohol not only increases the poisonous action of waste products but also hinders the removal of such products by its inhibitory action on the secretory cells.

MORBID CHANGES IN THE KIDNEYS.

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Similar changes to those already mentioned as taking place in the heart and liver occur also in the kidneys. There may be fatty infiltration and fatty degeneration associated with an increase in bulk particularly in the case of the beer drinker's kidney. But alcohol may also lead to granular contracted kidney especially if a gouty condition of the system has already been produced. The blood vessels of the kidney manifest changes resembling those that occur in the blood vessels generally.

Fibroid changes similar to those found in the liver take place in the kidney, leading to the production of cirrhosis of this organ. Prof. Woodhead ⁽²⁾ remarks:- " It is a curious fact that this distribution of fatty degeneration in alcoholics is very similar to that which obtains in cases of diphtheria and other bacterial poisonings,

(1) The "Practitioner" Alcohol Number- Novr 1902. page 545

(2) Med. Temp. Revw. Jany, 1903. Page 12.

"so that we must assume that we have in alcohol a substance which produces essentially the same changes in the muscle fibres as do these bacterial products!"

PATHOLOGICAL EFFECTS OF ACUTE ALCOHOLIC POISONING.

The changes spoken of as arising from chronic indulgence in alcohol may also arise from chronic alcoholic poisoning. Prof. Woodhead⁽¹⁾ describes two cases of such which came under his own notice, both were comparatively young people the alcoholism being of short duration. Both patients died during an attack of delirium tremens from cardiac failure. Both had been healthy up to the time they had commenced to drink. At the post-mortem examination the left auricle and ventricle were found dilated. In the wall of the ventricle there were areas of fatty degeneration especially in the musculi papillares; there were also a number of small red patches in the muscular wall, some of which seemed to be due to actual haemorrhage. There were also yellow patches of acute fatty degeneration. The red or grey areas were found to be patches of acute myocarditis.⁽²⁾ "Of which the most prominent feature was an accumulation of leucocytes in the immediate neighbourhood of the capillary vessels running between the muscle fibres, whilst the muscle fibres themselves were evidently undergoing most profound changes". Similar changes were taking place in the liver. The cells of the peripheral zone of the lobule showed fatty infiltration, and throughout the lobule there was slight fatty degeneration. Along the

(1) Med. Temp Revw. Feb 1903. pp 43 & 44.

(2) Ibid p 43.

lines of the small portal veins were seen numbers of poly-morpho-nuclear leucocytes, and an increased number of connective tissue cells. In the endothelium of the small portal veins, and of the small branches of the hepatic artery there were, here and there, evidences of cloudy swelling.

Both in the heart and liver there was distinct evidence of increased connective tissue formation, such as is commonly found in the most chronic processes.

MORBID CHANGES IN THE NERVOUS SYSTEM.

(1)
Kleefeld, investigating the changes in the nervous system, has brought to light the fact that alcohol when introduced into the blood produces almost instantly a retraction of the minute branches of the neurons, or at least, of a great number of them. He has also shown that alcohol produces various deformities of the neurons.

(2)
Kleefeld's experiments were carried out as follows—The brains of a rabbit were ~~ex~~posed by trephining the skull. Two openings were made, one on each side of the head. After the animal recovered from the shock of the operation a small dose of well diluted alcohol was injected, and fifteen minutes later the wound of the scalp was opened, a portion of the brain snipped off and prepared by Golgi's method, and examined under the microscope. Two days later, when the animal had recovered from the effects of the alcohol, another specimen was taken in the same way from the opposite side of the brain.

(1) Cited by Kellog in Med.Temp.Revw. Octr 1902 p.299

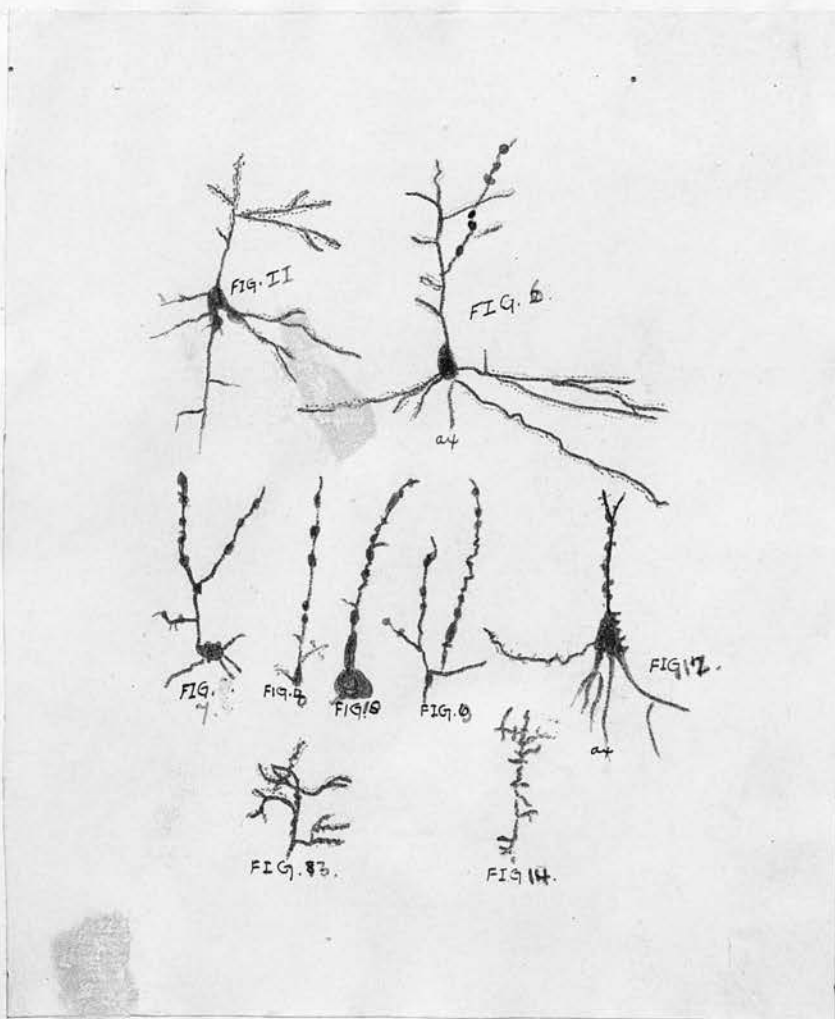
(2) Ibid page 299.

This again was examined under the microscope, then the two specimens were compared.

(1)

The following changes were observed in that specimen taken from the rabbit while under the influence of alcohol:- retraction of the branches of the cell,

NOTE:- (The following figures are copied from "Brain" part 2. 1875 Article by Berkley on "Studies on the Lesions produced by the Action of Certain Poisons on the Cortical Nerve Cell".
 Fig. 13. shows the terminal portion of a Normal Dendrite.
 Fig. 14. shows a degenerated Dendrite.
 Figs 6 & 11 show a slight degeneration, 11 showing excavation of the body of the cell.
 Fig. 7, 8, 9 10, & 12 show advanced degeneration.)



beaded and varicose appearance in these branches which ought to be of nearly equal thickness. Prof. Woodhead⁽¹⁾ says:- The fine lateral twigs either disappear altogether or become swollen and shortened, as the moniliform swelling increases and the lateral twigs disappear the protoplasm nucleus and nucleolus of the nerve cell become more and more altered. The cells become shrunken and atrophied and pigment is deposited in them. In other cases the protoplasm of the cell becomes vacuolated.

(2)

According to Prof. Woodhead "The pathological changes are to be found in the outlying and terminal branches of the nerve cell long before any demonstrable changes can be found in the body of the cell. This being thoroughly in accord with clinical phenomena, the more delicate co-ordinated processes being lost both temporarily and permanently in a much earlier stage than are what may be called the fundamental nerve cell activities."

(3)

Berkley has demonstrated that the deformed condition of the cells spoken of by Querton as being present during hibernation of the marmot and dormouse and described by Manouélian as the result of exhaustion in mice was always present in the habitual drunkard.

(4)

Berkley also points out that the changes observed in the brain of a slowly alcoholised rabbit are found in the brain of the man who has suffered from chronic alcohol poisoning; and he says " We regard them as

(1) Med. Temp Revw. March 1903. pp 76 to 79. Also Lees & Raper Lecture 1903. page 19.

(2) Med. Temp Revw. March 1903 page 79.

(3) Cited by Kellog in Med. Temp Revw. Octr 1902. p299

(4) Brain. part 72, 1895 page 495

"capable of being reproduced by any irritant drug, or bacterial toxic product circulating in the blood, and acting for a considerable time on the living protoplasm of the nerve cell".

(1)

Kleefeld has shown that the retraction of the dendrites and their beaded and varicose appearance immediately follow the presence of alcohol in the blood, appearing within 15 minutes after its introduction into the circulation of the animal. Showing, he continues, that the condition which has become permanent in the habitual drunkard exists temporarily in a man or an animal subjected for the time being to alcohol. The same effects were also found to follow the introduction of ether, chloroform and other narcotics .

(2)

Kleefeld further observed that the cells of the bulb were much more resistant than those of other parts of the spinal cord, and also than those of the cerebrum". This may account for the phenomenon which everyone has observed, namely, that the respiratory and cardiac centres remain practically unaffected even when the higher brain functions are completely paralyzed as when a man is "dead drunk".

(3)

Kleefeld summarises his observations on this subject in the following words" The modifications which we have observed are capable of explaining the phenomena of drunkenness. The disorder of ideas, the suppression of the reasoning faculties, the incoordinated movements, the hallucinations are all due-as we believe- to a partial retraction of the neurons and to pathological circuits organized in the centres".

(1) Cited by Kellogg in Med. Temp Revw. Octr 1902. page 299

(2) Ibid page 300.

(3) Ibid page 300.

a considerable time prior to the onset of the inflammation of the nerves, and he states that the neuritis is "rather a symptom or complication than a disease^{of} it-self.....just as delirium tremens is apt to supervene as the result of the onset of acute diseases like pneumonia or typhoid fever, or as a result of accident or exposure, so also is neuritis; it is only indeed when all the other symptoms and organs are perfectly sound that alcoholic neuritis is to be dignified by being regarded as a special disease".

It has been shown that alcohol causes degenerative changes in various tissues of the body, changes affecting such important organs and tissues as the liver, heart and blood vessels. These tissues and organs, as well as others, suffer from fatty and fibroid degeneration. Having regard to the vital importance of these organs to the animal economy, one naturally concludes that disease and degeneration in them must lead to premature death, and if so one would expect to find evidence of this in the statistics of life assurance companies, more particularly in those which have kept separate accounts of the lives of abstainers and non-abstainers. It is generally admitted that these companies have been in existence a long enough period(one at least for over 40 years) and have dealt with a sufficiently large number of lives to make these statistics valuable and reliable; and it is a significant fact, that the Directors of these companies now offer lower premiums or extra bonuses to

total abstainers. The following table is found in the report of the Directors of Sceptre Life Association, presented February 23rd, 1905.

MORTALITY EXPERIENCE.

The claims by death expected during the past year (calculated by the Institute of Actuaries' Hm. Mortality Table), as compared with those which actually occurred, were as under:---

GENERAL SECTION.

TEMPERANCE SECTION.

Expected Deaths	Actual Deaths	Percent-age.	Expected Deaths	Actual Deaths	Percent-age
145	120	82.76	114	58	50.88

The foregoing figures emphasise very strongly the valuable sources from which the Association derives its business, and as showing that the favourable mortality is not confined to 1904, the following results for the past twenty-one years are given:-

GENERAL SECTION

TEMPERANCE SECTION.

Period	Expected Deaths	Actual Deaths	Per cent age	Expected deaths.	Actual deaths.	Percent age.
5 yrs. 1884-1888	466	368	79.00	195	110	56.41
5 yrs. 1889-1893	564	466	82.62	312	184	58.97
5 yrs. 1894-1898	628	498	79.30	419	228	54.42
6 yrs. 1899-1904	857	668	77.95	628	328	52.23
Total 21 years.	2515	2000	79.52	1554	850	54.70
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The following table gives the Mortality Experience of the Scottish Temperance Life Assurance Company:-

MORTALITY EXPERIENCE.

Twenty-one years 1883-1902

Period	Temperance Section.			General Section.		
	Claims expected	Actual Claims	Ratio	Claims expected	Actual Claims	Ratio.
1883-1887	43	15	35%	11	7	62%
1883-1892	159	79	50%	49	33	68%
1893-1897	290	138	48%	95	67	70%
1898-1902	444	188	42%	164	118	72%
	936	420	45%	319	225	71%

The actuaries of the United Kingdom Temperance and General Provident Institution report that the mortality of Whole Life Policies has been as follows:-

	EXPECTED		ACTUAL	
	<u>Claims</u>	<u>Amount</u>	<u>Claims</u>	<u>Amount.</u>
Temperance Section	406	£115,974	308	£74175
General Section.	449	£124,167	393	£101,625

Dr Ridge states that the returns of Life Assurance Offices "show that total abstainers live, on an average, eleven years longer than non-abstainers".

The mere collecting of "notes" respecting the physiological action and pathological effects of alcohol impresses one with an admiring sense of the stupendous amount of painstaking labour and critical analysis that experimenters and investigators have lavishly expended in their search for definite knowledge on the subject.

Nor has the labour been in vain, for some points at least are now considered "proven". Amongst such may be noted the extent to which alcohol is oxidised in the body, its action on the temperature of the body, its power to produce fatty and fibroid degeneration etc., Much, however, still remains to be done, for many points are as yet more or less obscure:- as, the action of alcohol on the "isolated heart," on the velocity of the blood current, on respiration; and the controversy respecting the food value of alcohol continues even though that

controversy turns largely on the definition of what constitutes a food.

Believing that a large percentage of the more intelligent section of the community will ultimately abide by the definite "findings" of medical men regarding the action and use of alcohol, one feels anew the great responsibility resting upon the profession, for there is no denying the importance of the use of this substance not only to individual and family life, but also to the life and welfare of the nation generally.

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