what it has been among insured lives in the United States. But what is even more interesting is the fact that the deaths from alcoholism have gone down during the last ten years in Canada—a condition very different from that in the United States. In so far as death rates are a reliable indication, the Canadians seem to have succeeded much better than we in their efforts to control the problem of alcohol and of alcoholism."

I know that you will pardon my quoting *in extenso* from Dr. Dublin's article. Dr. Dublin is certainly against the drinking of the highly deleterious stuff that passes for alcoholic beverages these days.

Professor Raymond Pearl of the Johns Hopkins University, Department of Biology, has analyzed the age of the deaths in Johns Hopkins Hospital of over 2,200 persons. In order to show the effect of alcohol on the age in which these persons have died, he has classified them into three groups—the abstainers, the moderate drinkers and the heavy drinkers. His statistics show that the moderate drinkers outlive slightly the group of abstainers, 45.10 to 45.2. The statistics from the alcoholic wards of Bellevue Hospital show that there has been no decrease from deaths due to alcohol since the constitutional prohibition was enforced, namely, at midnight on January 15, 1920, a little over eight years ago.

II.

A STUDY OF THE ALCOHOLIC CONTENT OF AUTOPSY MATERIAL, AND ITS BEARING ON THE CAUSE OF DEATH

ALEXANDER O. GETTLER

Before taking up the question of alcohol, will you pardon me if I diverge a little and take a few minutes in talking about the chemical and toxicological department of the Chief Medical Examiners' Office. Very few people in New York City know that such a department exists; in fact

there are many people in New York who do not even know that a Chief Medical Examiner's office exists. It was only because of supreme effort on the part of Dr. Norris, that New York City consented to have the toxicological laboratory installed. My main reason for talking about this department is because of statements made that so little research work has been published and the material at hand is so large. I will give you a short summary of the work of the Department of Toxicology.

The laboratory is situated at Bellevue Hospital on 29th Street and First Avenue. It takes care of all the chemical and toxicological work of the Medical Examiner's Office from the five boroughs, Manhattan, Brooklyn, Bronx, Queens, Richmond. In this laboratory there are analyzed annually approximately 1500 cadavers. Each cadaver may necessitate the analysis of several organs—the liver, brain, spleen, kidneys, etc. The analysis of one cadaver may sometimes take several days. There are of course, some analyses like alcohol which are completed in a couple of hours. Besides these analyses of cadavers, the Chemical Department does work at the request of the Police Department such as examining blood stains, medicines, liquors, hair, weighing bullets, and other odds and ends. Then I am also called to District Attorney's Offices in all of the five boroughs as a consultant. The District Attorney does not come to my laboratory but I have to go to each respective borough. All this is very time consuming.

I am also called to testify before Grand Jury, Court, or compensation referee. The court work is the least thankful of all. The work is done as scientifically as possible. The results are interpreted in an honest way. At the time of the analysis I do not know whether the defending lawyer or the District Attorney is going to ask me to appear. Results of analyses are filed with the Chief Examiner as soon as completed, and long before the matter goes to court. When the case comes up I am subpœanaed to testify. The opposing lawyer then tries to "show you up" by asking all kinds of tricky questions. I will give you one very short instance.

This was a case of an automobile accident, with ensuing death. I testified that the man was intoxicated at the time of death because of the amount of grain alcohol I found in his brain. The lawyer for the defense then got up and cross-examined me. He picked up a book from his table, opened it, looked at me, and asked, "Do you know Single?"

I looked at him, I did not know what he meant. I thought he had a book written by a man named "Single." So I said, "No, I have never heard of him."

He looked at me and smiled at the jury. He asked me again, "You do not know what Single is?"

Then it occurred to me what he meant. There is present in the brain tissue a substance called Sphingol. This happens to be a chemical substance, a solid which has hydroxyl groups and is chemically classified as one of the substances belonging to the large group known as alcohols. So I said to him, "I think I know what you mean. You mean Sphingol."

He said, "Yes, what is it?"

I said, "It is an alcohol."

"Oh well then, everybody has alcohol in his brain has he not?"

I said, "No. Not grain alcohol."

He looked at the jury and smiled, and said, "That's all." The District Attorney should have cleared up this point. I suppose he did not know enough chemically to do it. Such are the things we are "up against."

You can all see by this short review that the work of the Chemical Department is quite lengthy. Now what is the staff which does this work? We have in the Chemical Department three individuals—myself and two assistants. The total outlay in salaries is $4700 and dividing that by fifteen hundred cadavers it means that an analysis of a cadaver costs New York City just three dollars. The Police Department work, the District Attorney Office work, the court work is thrown in gratis.

If a person knows the conditions above referred to, I do not think he will ask, "Why has not the Department done more research work, having such wonderful material?" We have wonderful material but we have not got the time. Our time is taken up too much by routine work, and even so we have been able thus far to work up chemically and publish about twenty-four papers on different subjects. One of these papers is on alcohol and is the one I will bring to your attention to-night before I talk about these samples of liquor which have killed people.

The work which I want to talk about first, is a method by which we can tell by analyzing the brain whether a man or woman was intoxicated at the time of death. Intoxication, of course, may be contributory to automobile accidents, to vocational accidents, etc. One important question that has always been put to me when in court or before the compensation referee, was this man intoxicated? That question could never be answered definitely because, first, we did not have methods that were tried out well enough so that we were sure they were accurate methods for determining alcohol in tissues; and secondly, we did not know whether the alcoholic content of organs was anv index to intoxication. These two points we have solved.

First one must bear in mind that this method must detect and quantitatively determine extremely small amounts of alcohol. Amounts as small as four drops of alcohol in the entire brain (0.01%). Then this small amount of alcohol is intermixed with a large amount of body tissue.

We first tried out various methods found in the literature but had to discard one after the other. I will simply run over them quickly. We tried first the method of Nicloux, titrating the alcohol in the brain distillate by a dichromate sulphuric acid mixture. This did not work because there are other volatile substances in the brain tissue which react with chromicsulphuric acid. We tried oxidizing to aldehyd and determining it. Then we tried the methods which are based upon the formation of iodine

compounds (ethyl iodid). We found these methods useless for small traces of alcohol.

We tried to determine it by specific gravity or by refractive index. These also had to be discarded. The methods which seemed to give us best results were those in which the alcohol was oxidized to acetic acid and then the acetic acid titrated with very weak standard alkali solutions and upon this principle we finally developed a method that is quantitative.

At first when this method was tried, we obtained very inconsistent results. Amounts of reagents to be used, and optimum conditions for the best recovery were finally worked out. Under these conditions we were always able to recover between 83% and 86% of the alcohol added. The average is 84.5%. By multiplying this by 1.18 we obtain the total alcohol present.

It might seem that a difference between 83% and 86% is very large. But when you consider that the total amount of alcohol in a brain is only in the neighborhood of 0.35% the difference between 83% and 86% (error ±1.5%) is not much. It simply means that if a brain contains 0.35% alcohol, I will obtain by this method a result somewhere between 0.345% and 0.355%.

The method developed is as follows: Five hundred grams of brain material are ground up. Enough water added to make mixture fluid, acidified with tartaric acid, little white oil added to prevent frothing, and then distilled with steam. Eight hundred c.c. of distillate are collected. To 300 c.c. of this distillate are added 20 grams of potassium dichromate and 40 grams of sulphuric acid. The mixture is distilled at a slow rate until 250 c.c. are obtained. This distillate is titrated either with 1/50 normal or 1/100 normal alkali. From the titration figure the alcoholic content is calculated.

Now as to the question, is alcohol in the tissues an index of intoxication? If we find alcohol, what does it mean? Several points had to be cleared up. First, what organ or

tissue is best for analysis in order to determine intoxication. We have tried brain tissue, liver, lung, kidney, and we found that the brain gives us the best index of intoxication, which of course one would expect. Still it had to be proven as a fact.

The next point, is alcohol normally present in the brain? That is in people who imbibe no alcohol. Is there ever any alcohol present in the brain due to normal metabolic processes? There is a great array of literature on this subject. Among the various workers in this line Ford, Nicloux, Landsberg, Maignon, Pringsheim and Schweisheimer have reported the presence of traces of alcohol in human brains, although the individuals had not consumed any. Most of these workers, however, did not use human brains, they used animal tissue and human blood. They found that the amount of alcohol present ranges from .001% to 083%, very small traces.

Another series of workers trying to determine whether alcohol is present normally or not, not trying quantitative methods, but just qualitatively, such men as Bechamp, Rajewsky, Vitali, Nicloux, Stocklasa, Arnheim, Rosenbaum and Umber came to different conclusions. Some of this group stated that alcohol is present normally; others of this group that alcohol was not present normally. The reason for their opposite conclusion is mainly due to the fact that the tests which they used were not specific for alcohol. They used tests such as Moore's, Schiff's, Nessler's, Lieben's, which are not specific for alcohol. To date therefore it has not been proven whether alcohol is present or not as a normal constituent of brain tissue. In applying our method to human brain tissue (brain of people who had consumed no alcohol) we found that each one reacted slightly positive to our quantitative test. The amount is very small, about 7 mg. in 1000 grams of tissue.

Let me outline the chemistry of this test. Alcohol is C_2H_6O, and when oxidized it is converted into acetic acid. This latter can then be titrated, and from the titration

figure the alcohol calculated. When normal (non-alcoholic) brains are distilled and oxidized, a small amount of acid is also produced. Whether this acidity was produced from ethyl alcohol normally present or some other volatile substances we can not say. We have proven however that if it is alcohol, the amount present normally is always less than 25 mg. per kilo of brain. I might add that 25 milligrams in a kilo of brain means about one half drop of alcohol in the entire brain. This is the limit of the alcoholic content of a person who never takes alcohol, provided it is alcohol, which has not been definitely proven.

I might say at this stage that I am now having under investigation this very point, whether the substance present in brain, volatile and oxidizable to acid is really alcohol.

Now we come to the alcoholic content of the brain of partakers. When this paper was written we had examined over 6,000 human brains of various alcoholic contents. The results obtained were compared with the histories of the cases in question. Of course when it comes to histories, one well knows that some of them must be taken with a grain of salt. We have tried to pick out those cases in which the histories were pretty definite and trustworthy. In many cases hospital records were used.

In the chart, the cases with an asterisk were habitual users of alcohol. The others were occasional drinkers.

Case 6 was one of intoxication, and in the hospital three and a half hours, the alcoholic content .315%. Notice the great increase over the normal. The normal was .0015. There is no question as to the presence of alcohol. The normal value is in the third decimal place.

With the plus signs we designate the alcoholic content for the Police Department and for the layman because the actual figures mean little to them.

Chart I.

Results of Estimation of Ethyl Alcohol in Brain Tissue

Case	History	Cause of Death	Gm. of Ethyl Alcohol per Kilogrom of Brain	Percentage of Alcohol in Brain	Arbitrary Classification
1	In hospital 12 days; no alcohol given	Heart	0.0062	0.0006	Absent
2	In hospital 18 days; no alcohol given	Mercury poisoning	0.0195	0.0019	Absent
3	In hospital 8 days; no alcohol given	Nephritis	0.0156	0.0015	Absent
4	In hospital 24 days; no alcohol given	Heart	0.0095	0.0009	Absent
5	In hospital 15 days; no alcohol given	Pernicious anemia	0.0116	0.0011	Absent
6*	Intoxicated; in hospital 3½ hours	Alcoholism	3.150	0.315	+++
7	Intoxicated; in hospital 2 hours	Alcoholism	5.780	0.578	++++
8*	Found dead; seen intoxicated ½ hour before	Alcoholism	2.980	0.298	+++
9	In hospital 8 hours; not intoxicated, but aggressive	Alcoholism	1.760	0.176	++
10	In hospital 3 hours; intoxicated	Alcoholism	2.890	0.289	+++
11	In hospital 4 hours; not intoxicated, but aggressive	Shot	2.040	0.204	++
12	Intoxicated; in hospital 2 hours	Fractured skull	3.540	0.354	+++
13	Intoxicated when fracture received; lived 14 hours	Fractured skull	0.550	0.055	+
14	Same as in case 13; lived 18 hours	Fractured skull	0.730	0.073	+
15	In hospital 5 hours; intoxicated	Alcoholism	3.010	0.301	+++
16	Not intoxicated; in hospital 8 hours	Fractured skull	0.110	0.011	Trace
17	Intoxicated; in hospital 5 hours	Fractured skull	3.660	0.366	+++
18*	Intoxicated; in hospital 1 hour	Fractured skull	2.930	0.293	+++
19	In hospital 1½ hours; not intoxicated, but carefree	Fractured skull	2.250	0.225	++
20*	In hospital 3 hours; intoxicated	Alcoholism	5.450	0.545	++++
21	Intoxicated 30 min. before death	Alcoholism	3.800	0.38	+++
22*	Intoxicated 45 min. before death	Hit by train	4.200	0.42	++++
23	Brought to hospital in coma	Alcoholism	2.690	0.269	+++
24*	Was drinking excessively to the end	Alcoholism	5.050	0.505	++++
25*	Intoxicated 25 min. before death	Hit by auto	3.420	0.342	+++
26*	Found dead; intoxicated 2 hours before	Alcoholism	5.250	0.525	++++
27	Not intoxicated	Heart	0.560	0.056	+
28	Not intoxicated	Gunshot	0.090	0.009	Trace
29	Not intoxicated; one drink 4 hours previous	Heart	0.410	0.041	+
30	Intoxicated 2 hours before death	Alcoholism	3.850	0.385	+++
31*	Not intoxicated; in hospital 6½ hours	Alcoholism	0.750	0.075	+
32	Not intoxicated but carefree	Stabbed	1.590	0.159	++

* Indicates habitués, others only occasional drinkers.

Case 7 was not a habitual drunkard but was intoxicated and two hours in the hospital. Case 8 was a habitual drunkard seen one-half hour before death in an intoxicated condition.

Glancing through the list we find that three pluses and four pluses are intoxicated. Among the one and two pluses we have thus far not been able to find one where the history showed us that intoxication was present.

This chart shows our classification of the cases.

CHART II.

CLASSIFICATION OF ALCOHOL CASES

Classification	Gm. of Alcohol per Kilogram of Brain	Percentage of Alcohol in Brain	Physiologic Effect
Trace	0.050 - 0.200	0.005 - 0.02	Normal
+	0.200 - 1.000	0.02 - 0.10	Normal
++	1.000 - 2.500	0.10 - 0.25	Loss of sense of care; aggressive
+++	2.500 - 4.000	0.25 - 0.40	Loss of equilibrium; intoxicated
++++	4.000 - 6.000	0.40 - 0.60	Unbalanced; intoxicated

Now as to affect. With a trace of alcohol the person looks normal, walks around normally and acts normal. Therefore one plus cases look normal. Two plus cases do not look intoxicated. Some have however lost their sense of care. They are a little aggressive—the modern hooch especially makes one aggressive. In the three plus cases there was a loss of equilibrium (intoxication) and the four plus cases were in the same condition only they were almost helpless. They were so badly affected that they could hardly walk. So by the amount of alcohol in the brain we can now say that we have an index for telling whether a person is intoxicated or not.

Against this many people bring forth the same question that is repeatedly asked of me in court, "Well, doctor, isn't it a fact that I can give the same amount of alcohol to two people, and one may become intoxicated and the other not?"

My answer to that is: We are not analyzing what the man gets to drink. We are not analyzing what the man

has in his stomach. We are not analyzing what the man has in his intestines. We are analyzing for the alcoholic content of the brain.

There is a difference between how much alcohol is in the brain, and how much did he drink, or how much is in his stomach. The amount in his stomach does not affect the brain. The alcohol in the intestines does not affect the brain. Once it gets to the brain, it has an effect and that effect is proportionate to the amount present.

There is experimental evidence in the literature on that same point. Rosenfield in 1901, working with animals, came to the conclusion that the reason habitués can stand more alcoholic beverage is because they have a more rapid oxidative power; that is, their organs can oxidize, burn up alcohol quickly and if they do that, then the alcohol does not accumulate in the brain as it does in other people, so it is a question of oxidation.

Reid Hunt in 1907 came to the same conclusion that tolerance is simply a matter of oxidation. If an animal has a high oxidative power toward alcohol he can stand more. If he has a lower one he can not stand as much.

Pringsheim in 1908 came to the same conclusion. He found that habitués burn alcohol in two-thirds the time. Further, he found that habitués burn up alcohol in all of the organs, not only in the liver. In occasional drinkers the alcohol is oxidized mostly in the liver, but in habitués all the organs have attained the property of oxidizing alcohol. He concludes his paper with the thought that tolerance is due only to oxidation.

Schweisheimer in 1912 corroborated Pringsheim's theory that tolerance is due to more rapid oxidation and found no evidence for increased resistance by the cells.

The foremost workers in this field, all come to the same conclusion that habitués can tolerate more because they have a greater oxidative power toward alcohol.

Our work consisted in taking alcoholics with sudden death, and having a definite history, and analyzing the brain. As far as we have gone, our cases seem to show exactly the same things as these men found in animal experimentation. So much for the alcoholic content of brains.

Now a few words on alcohol deaths. Alcohol deaths in New York City seem on the increase. Dr. Norris has outlined to you not only New York City, but the increase in other states. Now the question of course arises, what is the cause? First, more general drinking. I am talking, of course, mainly about New York City because that is the city I am familiar with. There is more general drinking to-day. It is heroic to have the hip pocket flask not only for grown-ups but youths in their teens; boys and girls have drinking parties. There are many more speakeasies to-day than there were saloons. In going around it its surprising to see cigar stores, candy stores, drug stores, grocery stores, all have as a sideline the whiskey trade. In one block near the hospital, as far as I have been able to estimate, there are about fifteen speakeasies and I have not been able to spot them all. Bootlegging, furthermore, is a very profitable vocation. Many are turning to bootlegging now.

The second cause is the kind of material. Of the whiskeys that come to my attention I would say that 95% of them are really unfit to drink. Some are denatured by the various denaturants which the government puts into them. That group of denaturants is very large. I will just mention a few of them. I found among the denaturants wood alcohol, fusel oil, formaldehyd, phenol, aniline, benzine, nitro-benzine, ether, quinine, nicotine, mercury, bichlorid, diethylphthalate.

Some of the liquors obtained are denatured, some of them are simply freshly distilled mash, that means freshly fermented and distilled whiskeys, raw alcohol; and still others are simply mixtures of alcohol and water and sugar and caramel and a little bead oil and whatever else the bootlegger may have he chucks in, puts them into a barrel

and shakes up the barrel. I have been told lately by one of my assistants that they even buy old whiskey barrels, and cut up the barrel, and extract the wood of the barrel and mix that extract into their whiskey. That is a resumé of the kind of liquors which are being sold.

I have brought these samples in case some are interested to see them. These samples I gathered from various cases submitted to me. I picked out colorless glass bottles of the same kind. I really do not think I should have done that. I should have brought up the various kinds of bottles as we get them but the reason I brought these is because they are transparent glass and you can see the nature and color of their contents. All these that you see here are either denatured or raw fresh alcohol and most of these have produced death.

Of course some denaturants are more poisonous than others. The most poisonous of all is wood alcohol. After that pyridine and fusel oil. Some of the others are not so very poisonous and one drink will not kill a person but if he keeps on drinking the same denatured material it is bound to have an effect.

As to the poisonous effect of raw alcohol, fresh mash whiskey, which has not aged, I can say very little because I really think very little is known. But what we know is perhaps this: Fresh whiskey even made in the regular old fashioned way but freshly distilled contains besides ethyl alcohol, a large number of other substances in small traces. Among the alcohols it contains propyl alcohol, butyl alcohol, amyl alcohol, glycerine. It also contains traces of acid such as propionic acid, butyric acid, valeric acid, capric, succinic. It also contains aldehydes. The main part of freshly distilled whiskeys is ethyl alcohol. These other substances are present in very small traces.

What effect these above mentioned substances have upon the organism is also not well known. It seems to be a continual irritation on all the cells and tissues.

On aging, these substances combine with each other to form esters. These esters are more pleasing in taste and much less toxic and irritating.

The aging, therefore, does away with the irritating effect, and produces a pleasant flavor. The consensus of opinion seems to be that aging is simply the neutralization of various substances in ordinary fermented material.

I have also brought up here two of the latest denaturants which the Government uses and perhaps some of you would like to see them.

In conclusion, the fatalities due to alcohol I would say are due first to alcohol excess; second, to denatured, poisoned liquor; third, to raw fresh whiskey and this raw fresh whiskey seems also, as I said before, to produce an aggressiveness of the bravado type. It is not so far fetched to say that perhaps many of these hold-up individuals get a lot of their psychical effect from this kind of alcohol. Of course there are other reasons also which do not come into this subject but I think it is not far fetched to say that that is one reason.

The complete prohibiting of alcoholic beverages has also led to a much greater use of drugs.

Beyond this my experience has been such as to agree with the statements in the book which I have read lately by Raymond Pearl of Johns Hopkins, published in 1926, where he has found from a large number of statistics that moderate drinking of bonafide material lowers the mortality and there is a greater expectation of life. Experiments on animals all practically seem to show beneficial effects.

Hence in conclusion I might say it would be far better to make proper use but avoid abuse.