

Tobacco and Health Research $\frac{1}{2}$

Where Shall We Go From Here? 28

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It is a pleasure to be here with you tonight where I can see again a number of old friends and have an opportunity to make some new ones. Despite that pleasure, I do not feel ^{bravely prudent} ~~a kind of hesitation~~ about mounting this platform to speak again about research on tobacco use and human health. ^{What I have to say is not in the nature of entertainment.} I know that you all must be rather weary of the subject and wish that it could be ignored or forgotten, with its reminders of difficult and unpalatable problems. I sometimes feel this way myself, especially when confusions, misapprehensions, contradictions and misunderstandings seem to be in possession of the field. But these problems cannot be ignored and they are not likely to evaporate in any near future. Whether we like it or not, we must grapple with them. Facing this fact, as we must, we come to the question I have put before you tonight, "where do we go from here in tobacco and health research?" I will try to give you a few answers to this question, as I see them, and some reasons for these answers.

Within the last few weeks we have witnessed two events that illustrate the kinds of confusions, misapprehensions and ^{contradictions that} ~~misunderstandings~~ I have mentioned. The first of these events was a series of hearings ^{during the week of Aug. 24} before the Consumer Subcommittee of the Senate Commerce Committee on the general subject of "making cigarettes safer." The other event

was the World Conference on Smoking and Health during the week of September 11. No doubt you have seen a number of reports from both.

In the hearings on "making cigarettes safer" some extremely divergent points of view were expressed. For example, one witness advocated a "cigarette" made from treated lettuce leaves on the ground that its smoke is entirely free of nicotine. Such lettuce cigarettes do ^{however} ~~nevertheless~~ produce smoke, and this smoke, ^{like other} ~~is~~ ^{produced in a similar manner from plant matter} consists in part of particulate matter, ^{this} ~~that~~ can be condensed ^{in the form of a dark} ~~into a liquid~~ of a

^{some} ~~into the kind of~~ dark liquid that has come rather generally, though erroneously, to be called "tar" ^{in the case of tobacco.} As luck would have it,

another witness at the same hearing reported experiments showing that ^{such} smoke condensates from burning dried lettuce have ^{exactly} the same kind of action ^{body} ~~on the~~ painted on the skins of mice as the ^{smoke} condensates from ordinary commercial tobacco cigarettes. Smoke from dried cabbage leaves ^{was} ~~is~~ ^{also reported to have} a similar ^{action} ~~but~~ ^{later} ~~is~~ ^{my dissatisfaction with} higher activity.

I shall comment ^{later} ~~upon~~ ^{my dissatisfaction with} mouse skin painting as a test method. At this point I will only say that these mouse-skin tests with lettuce and cabbage smoke condensates turned out just as any chemist or ^{biologist} ~~biologist~~ would have expected. The advisors of the Council for Tobacco Research ^{never thought} ~~did not think~~ it worth the cost ~~to~~ in

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terms of your money to carry out an experiment of this kind. I am inclined to feel that it was a dubious investment of the tax-payers money for anybody to have conducted this test. nevertheless I am rather glad that it was done since it was one way of demonstrating, ^{albeit rather} ~~that there is~~ ~~expensively~~ and unnecessarily, that there is nothing unique ^{in this respect} about the leaves of the tobacco plant ~~and~~ that the mouse-skin activity ^{of condensed smoke from plant material} does not depend in any way upon the presence of nicotine.

Other special and individual ^{view} view-points were presented at these hearings, which we shall not go into here. It was noteworthy, however, that a good part of the testimony was based upon acceptance of the concept that the goal to be ^{sought} ~~attained~~ in producing "safer cigarettes" is simply reduction in the amounts of "tar" and nicotine received by the consumer while ~~preserving~~ ^{is preserved} enough flavor to make the product acceptable. Most of the inventions described were aimed at this goal and claims of the inventors were stated in terms of nicotine and "tar" delivery without any biological tests to provide any direct basis for claims of greater safety.

A few witnesses showed a broader grasp of the problems involved and described ^{more} sophisticated long-range programs that ^{hopefully may in time} ~~might eventually~~ discover specific effects

is approval such constructive plans.

attributable to specific smoke components and lead to improvements. But overall, my impression was that a number of ^{inventors} ^{have been} ^{concentrating} ^{entirely} upon the reduction of "tar" and nicotine delivery because they have interpreted the various releases from the U.S. Public Health Service as authority for the assumption that a blue-print for the "safer" cigarette ^{already} has been established in these terms.

This brings us to the World Conference on Smoking and Health. Its whole plan was based upon the assumption that the use of cigarettes has already been established as a major health hazard. Hence the scientific evidence bearing on this point was not a topic for discussion. Instead the emphasis was placed upon methods for dissuading people from starting to smoke or of persuading them to stop. Some relatively minor attention was given to the question of how cigarettes might be made "safe" or "safer". In ^{this} ^{rather} ^{discussion}, again, the basic assumption ^{was} ^{clearly} ~~was~~ ^{maximum} ~~was~~ ^{to be} that the desired goal is a reduction of "tar" and nicotine while still producing a product that confirmed smokers might accept.

In his keynote address, Surgeon General William H. Stewart stated (partial quotation):

~~states~~ The 1966 cigarette is, on the average, substantially safer than the 1960 cigarette; it contains about two-thirds as much tar and nicotine. This competitive response to public concern has resulted in positive public benefit." Again he said: "For the tobacco industry and its advertisers there are a number of productive courses of action awaiting only the decision to help society cope with a problem that cannot be washed away. Among these are a sincere and wholehearted effort to develop a cigarette that is both as low in hazard and as acceptable to the smoker as science and technology can make it; --- The door to cooperation has always been open. It remains open." Such statements led one writer to characterize the speech as "an olive-branch held out to the cigarette industry."

Dr. Daniel Horn, Director of the U.S. Public Health Service National Clearinghouse for Smoking and Health, in leading a panel discussion, took a rather philosophical view toward smoking, ^{he} devoted much of his talk to a review of man's search for stimulants and tranquilizers: He said in part, "Throughout history people everywhere have searched for natural products in their environment which would provide them not only with sustenance and shelter but certain pleasurable effects as well. In his search for gratification

man has experimented with things to drink, sniff, smoke, chew or swallow - - - - . We must face up to the fact that the cigarette caught hold because it fulfilled certain functions that needed to be fulfilled for a great many people. The cigarette offered an accessible, inexpensive way to deal with a variety of problems - - - if there were no harmful consequences, it would have served mankind well. We simply had the rotten luck to have discovered after all these years that the harmful effects are overwhelming - - -". (Partial quotation)

The Council for Tobacco Research did not participate as such in this World Conference because its primary topic ^{did} not lie within our area of concern or competence. ^{of the Council were perfectly free to participate if they saw fit to do so} ^{But the Council does not take any position as to whether people should or should not smoke. Our function is entirely descriptive. Vast numbers of persons have smoked cigarettes in this country since the turn of the century. Vast numbers of persons are smoking them at the present time. The indications are that vast numbers will continue to do so for a long time to come. Hence our task of observing and describing the effects of smoking, good or bad, continues to be relevant and important. We have never assumed or asserted that ^{cigarette} smoking is free from any hazards. Indeed,}

...and it does not participate in advocacy.
 ...this would be the need for a research program.

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I do not suppose that any cigarette smoker in the country since the turn of the century ^{has} never assumed or believed that smoking was completely harmless. ^{He was led there by} His parents, teachers, scout leaders and other adult advisors ^{who} probably tried to ^{discourage} ~~discourage~~ him from smoking. We all know that there are definite hazards in eating, drinking, ~~for~~ athletic sports, swimming, drinking beer and taking a bath. But ^{the} cigarette smoker has hoped that the pleasures and benefits of smoking ^{might} ~~could~~ outweigh any dangers that he might ~~incur~~. Dr. Horn has acknowledged the benefits, though a full account of these has certainly not yet been rendered. Is he right in his conclusion that "the harmful effects are overwhelming"? This is still the key question and we do not think that it has yet been answered for reasons that I will explain.

~~It was~~ Dr. Stewart's call ~~for~~ cooperation from the industry, ~~it~~ seems to me ~~that he was being~~ anachronistic. The industry long ago undertook not only cooperation but leadership ^{in making reliable answers.} They did so first by setting up and financing "The Council for Tobacco Research" as an independent commission of scientific and medical men to conduct investigations into any and all aspects of tobacco use and human health. Later they made a very substantial contribution, without strings attached, to the American Medical Association for a similar but separate program.
* ~~It~~ called the Tobacco Industry Research Committee.

It was certainly their hope and expectation that these programs would in time define and measure any hazards of cigarette smoking that are real, elucidate their mechanisms by laboratory and clinical studies, and trace them to specific ingredients of smoke. They gambled, so to speak, that ~~such~~ had a passing down of any real hazard ~~in the way~~ would probably show the way toward its elimination. Was this not an intelligent and honest attempt to provide an ^{answer to} what Dr. Stewart calls for - "a sincere and wholehearted effort to develop a cigarette that is held as low in hazard and as acceptable to the smoker as science and technology can make it." ^{microscopic} In their own company laboratories they continued the highly sophisticated work of identifying and determining quantitatively as many individual smoke ^{components} ~~components~~ as possible, ^{whether} condensable or non-condensable. They sought means of eliminating by filtration or otherwise, some of these components that can be presumed to be unnecessary or undesirable, ^{without waiting for} even though ~~there was~~ ^{any} real evidence that they contribute to the production or aggravation of any disease. The industry also made available a variety of relatively low "tar" and nicotine cigarettes ^{to meet public} ~~to the demand for~~ created by the implications of U.S. Public Health Service and other agencies ^{rightly or wrongly} that this is the ^{type to be desired for "society."} ~~deplorable~~.

I think there has been no lack of ~~a~~ cooperation, ~~of a~~ (very realistic and constructive) ~~nature~~. If, however, the present plea for cooperation implies acceptance of all the current doctrines, view-points and ^{dogmas} conclusions of the U.S. Public Health Service, there must be reservations. We of the Council are eager to cooperate energetically and effectively toward attainment of the ultimate objectives. This, we conceive to be ^{substantially} ~~an~~ ^{orderly} ~~reduction~~ ~~of~~ the toll of such constitutional diseases as lung cancer, cardiovascular ailments and chronic lung diseases in a population ^{still smoking} ~~that~~ ~~and~~ ~~enjoying~~ cigarettes and enjoying the pleasures and benefits to which Dr. Horn alluded.

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because they know that this is not publishable, in these publicity as they do not speak of their but a careless reader is it seems to be what Mr. Moran says,

class more when he says speaks of the harmful effect of cigarettes on smoking.

toward this end, we feel that our cooperation will be most effective in the long run if we maintain and exercise our independent judgment rather than adopt any "party line" imposed by others.

There is time this evening for only a few examples and illustrations of what I mean.

First let us take Dr. Moran's statement that the harmful effects of cigarettes are "overwhelming". On what evidence, actually, do he and his colleagues base ^{any such} statement? Their method basically ^{was} ~~is~~ this. The death rates of cigarette smokers and of non-smokers are compared and found to ^{be} higher for the smokers. A figure for the "excess deaths" among smokers is ^{then} obtained "by subtracting from the number of deaths occurring in a group of smokers, the number of deaths which would have occurred if that group of smokers had experienced the same mortality rates as a comparable group of nonsmokers."

concluding that these "excess deaths" are caused by smoking any thoughtful man in the street and to many a bright high-school student, as I have discovered by actual test. It has been pointed out by every one of the two dozen or so statisticians with whom I have discussed the matter. The fallacy is simply this: If we knew that the cigarette smokers were alike in all other respects and that the only difference was in their

Cigarette smoking may well be an
evidence or ^{some} indication of a combination
of such characteristics and habits.

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smoking or non-smoking, we ~~could~~ ^{might be able to} conclude that the difference
in mortality was caused by the smoking. But we know just the
opposite from such relatively meager studies as have been made
so far. And as more studies of this kind are accomplished,
the evidence ^{increases} that different physical and emotional characteristics
and habits of life are associated with cigarette smoking and
non-smoking. The needs which Dr. Horn ^{pointed out} as being met by
smoking certainly vary in degree and intensity from
person to person and the ^{heavy} smoking ^{population} group would be
expected to include a group whose life-expectancy is
relatively low because of ^{the intensity of} their physical and mental ^{unadjusted}
maladjustments. This situation ^{might} ~~would~~ be reflected in ^{the}
death-rates ^{among the whole group of smokers} even if ^{their} smoking helped in some degree to
^{relieve} ~~reduce~~ these maladjustments.

I recall a study which showed that people who
use tranquilizers have much higher death-rates than those
who do not. The author did not conclude that
tranquilizers kill people but rather that some of the
people who need tranquilizers are sick enough to
affect the statistical picture ^{of the group} by dying relatively early.

Similarly it was shown that people who regularly
spend ten hours a night in bed have higher death rates
than those who average ^{only} seven hours of sleep. It was
not concluded that ^{excessive} ~~too much~~ sleep ^{will} kills people, but

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rather that among the long sleepers there are enough people whose excessive requirements are due to illness to affect the mortality statistics. We would not expect the ~~life span~~^{longevity} of such people to be improved by restricting them to seven hours a night.

So far as the epidemiological method of approach to these problems is concerned, I cannot see any difference between the cases of sleeping habits, use of tranquilizers and of cigarette smoking. I am not denying the possibility that cigarette smoking may actually cause some excess deaths. I am only saying that this kind of study does not tell us ^{whether} ~~whether~~ ^{or not} ~~is the case~~ ^{whether} as any ~~idea~~ ^{solution} of how many such excess deaths are attributable to smoking. That is why the Council constantly stresses the need for new studies of quite a different character and is trying to lead the way by demonstration projects. We are giving assistance to a very ambitious study of human factors associated with relatively long life and with relatively early death. A tremendous number and variety of observations are being made upon the subjects of this study. Smoking habits are only one. We are trying to find out how other characteristics and life habits tend to be grouped with smoking or non-smoking. The handling and ~~analysis~~ of such numerous pieces

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of data requires the development of new computer programs capable of doing more quickly the kind of statistical sifting of factors that used to be done by multiple regression analysis or discriminant function analysis. We have therefore undertaken also to support the development and application of ~~such~~ ^{new and better and faster} computer programs for such purposes.

The methodology developed in these studies will be available for use by the ~~various~~ ^{various} government ~~agencies~~ ^{and other agencies} concerned with similar problems.

Already it can be said that cigarette smoking by ^{or in} groups of subjects ~~seems~~ ^{seems} to "summarize" ~~as~~ ^{groups of} other characteristics and habits which can serve statistically as "predictors" of relatively long or short life ^{without inclusion of smoking, ~~with~~ other factors} among these ~~persons~~ ^{or non-smoking} candidates for ~~study of~~ ^{possible causal effects}. We regard these ~~provisionary~~ ^{main} studies as ~~intelligent~~ ^{intelligent}.

exploration of

So far we have been discussing overall mortality rates in smokers and non-smokers of cigarettes. I want to say a few words more specifically about coronary heart disease.

coronary heart disease

This, as you know, is one of the ^{so-called} ~~prime~~ causes of death among American males. I have ^{calculated as shown before,} "excess deaths" from this disease among cigarette smokers, ~~constitute~~ ^{constitute} a large fraction of the total "excess deaths" ^{reported in} ~~the~~ ^{the} ~~smoking~~ ^{smoking} ~~population~~ ^{population}. All the comments we have made before about attributing ^{such "excess deaths"} ~~these~~ ^{causally} to cigarette smoking are applicable here as well. This was recognized by the committee that reported to the Surgeon General in 1964. They said

at that time: "nab cigarette smokers have a higher death ~~they said at that time~~ rate from coronary artery disease than nonsmoking males, but it is not clear that the association has causal significance." You will understand that I agree with this conclusion for reasons that have been explained. Moreover, I can not find in the data provided by continuation of the epidemiological studies any justification for a change in this conclusion. On the other hand there are several recent studies that tend to reduce the ~~possibility~~ ^{off-hand} likelihood that this is a causal relation. I can think of two in which ~~in~~ number of factors other than smoking were tested for their ability ^{to contribute to a} ~~as a~~ profile description ^{capable of serving as} ~~to serve as~~ valid "predictors" of coronary artery disease. In these cases cigarette smoking did not ~~help~~ contribute to the predictive power of the profile and was discarded. ^{It} ~~is~~ probably the most significant new contribution ^{is the recent} ~~to the~~ Swedish twin study. Identical twins are the nearest thing we have in the human species to the litter-mates of dogs, cats, mice, rats etc. Their genes are the same so that they have the same hereditary predispositions and tend to be much more nearly alike ^{even} in life-habits than fraternal twins or ordinary brothers and sisters. They even tend to be very much alike in smoking habits, which fact is one of the good evidences for

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the ~~concept~~^{belief} that constitutional make-up has an important effect in determining whether and how people smoke.

Nevertheless, the Swedish twin registry turned up a ~~substantial~~^{considerably} number of ~~identical~~^{pairs of} twins one of whom had smoked cigarettes ~~while~~^{for a substantial period} the other had not. Extensive

study of the cardiovascular ~~systems and function~~^{function} of these twins ~~showed~~^{showed} no ~~difference~~^{significant} ~~attributable to the~~^{between the smokers and non-smokers,} smoking. This ~~conclusion~~^{finding} might ~~be made conclusive~~^{have been finally conclusive} if the number of ~~pairs~~^{twins} had been ~~larger~~^{larger} and if

the study had been continued over a period of years. It is expected that ~~this~~ there will be follow-up at intervals, ~~and~~ A similar study of a larger number of twins pairs is urgently to be desired and

I recommend to our U.S. Public Health Service that this be given a high priority in their plans. It

~~could well~~^{will} ~~provide~~^{provide} some quite definite answers to the kind of difficult questions we have been discussing.

Meanwhile properly designed studies in animal models can probably help fill the gap since it is possible to use litter-mates (that is twins) in such studies and to make sure that all ~~factors~~^{environmental} are kept the same except for the one whose effect is to be assessed. The Council is planning further work along such lines.

In the recent Public Health Service Review, entitled The Health Consequences of Smoking, considerable attention is

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also given to the analysis of laboratory and clinical studies of the effects of nicotine, smoking or of smoke constituents on the heart and arteries. Many of these studies were ~~studies~~ sponsored by the Council. They included ^{investigations} ~~studies~~ of coronary blood flow, thrombus formation, serum cholesterol, free fatty acids in the serum, and the amount of arteriosclerosis found post-mortem. This was, in effect, a search for ~~possible~~ ^{effects and} mechanisms that might ^{plausibly} explain how and why smokers show a higher mortality from coronary artery disease. It was quite properly hedged with many "possibilities" and "perhaps" and "conceivably". In my opinion none of these offers ~~any~~ mechanisms or effects so far ^{described} offers any convincing explanation of the statistical picture. I will mention just one by way of ^{directly or indirectly,} illustration. Council studies have shown that nicotine, tends to increase blood flow in the small arteries that supply the heart muscle itself with oxygen. ^{The alkaloid} It also has a stimulating effect on the heart muscle much like that of mild exercise such as walking up a staircase. This is accompanied by a moderate increase in heart rate, systemic arterial pressure, cardiac output, stroke volume and muscular contraction.

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his coronary blood flow normally in response to metabolic stimulation. The reviewer intimates that smoking by a person with advanced heart disease may thus create a demand for increased oxygen in the heart muscle that cannot be met, and thus bring about a crisis or even death. He may well be right. My comment, however, is that a person so severely diseased as to be endangered in this way by smoking a cigarette would encounter a ~~similar~~ ^{comparable} hazard by dancing a slow waltz or climbing a flight of stairs. As we all know, people do in fact experience fatal heart attacks when engaging in these very activities. We do not conclude from this fact however, that exercise is a basic cause of coronary heart. There is evidence rather ^{help} that exercise, if regular and not too strenuous, will delay or compensate for the arteriosclerosis. I fail to see any significant difference between mild exercise and cigarette smoking so far as this particular set of mechanisms is concerned. It does not seem reasonable to me to suppose that such "last-straw" effects upon people in a precarious state of disease could have much influence on mortality rates.

To summarize then, it seems to me that one very large portion of Dr. Horn's ^{so-called} "excess deaths" among cigarette smokers are ^(the ones from coronary heart disease) very doubtful with respect to any causal implications, and ^{they} may well be removed from suspicion altogether. This event would greatly reduce the appearance

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of "overwhelming harmfulness" he mentions. To a greater or lesser degree this is true of other diseases included in the statistics. The evidence needs to be thoroughly analyzed in each and every case.

Since we have brought up the subject of nicotine, I must say that I cannot understand why it has become customary to link "tar" and nicotine together as related to the "risks" of smoking.

The 1964 report to the Surgeon General made a

~~rather extensive~~ review of nicotine pharmacology and draw the following conclusion:

"The rapidity of degradation to non-toxic metabolites, the results from chronic studies on animals and the low mortality ratios of pipe and cigar smokers when compared with non-smokers indicate that the chronic toxicity of nicotine in quantities absorbed from smoking and ~~and~~ other methods of tobacco use is very low and probably does not represent a significant health problem."

I have seen no research reports ^{since 1964} that suggest any ^{nicotine and tar} change in this conclusion. My only guess is that ~~they~~ ^{they} are linked together because the nicotine in cigarette smoke is found in the particulate phase which forms the chief component of smoke condensates. Hence cigarettes which yield a relatively small amount of particulate material are likely also to yield relatively little nicotine in the main-stream smoke. Epidemiologists attempting to relate disease incidence or mortality to the amount of daily smoke dosage find that the "tar" and nicotine dosages ^{are} associated. ^{To conclude from this kind of association, ~~that~~ ^{without this ~~type~~ ^{of} ~~reasoning~~ ^{reasoning} ~~thinking~~ ^{thinking}} that nicotine makes any contribution to the disease is very low ~~thinking~~ indeed.}

If there is no actual cause ~~since any ~~cause~~ ^{reasoning} ~~thinking~~ ^{reasoning}~~ against nicotine is a health hazard

is ~~comparative~~ ~~in the extent~~ and ~~some~~ ~~not~~ ~~very~~ ~~tightly~~ if nicotine ~~for~~ is responsible
~~provides~~ some of the ^{desirable} ~~beneficial~~ effects that smokers seek ^{as a desired}
it might be good ~~for~~ ^{health measure} to keep the nicotine content and ^{output}
output of cigarettes relatively high ~~as a health measure~~. This ^{should}
~~might~~ enable the smoker to obtain the ^{desired} ~~effects~~ nicotine
effects with a minimum exposure to other ingredients
of the smoke. If any of these are harmful, the reduced
exposure might be beneficial while satisfaction was maintained.

This brings me to the last ^{question} ~~point~~ that I shall
try to discuss tonight. On what evidence ^{are people basing their} ~~is the~~
doctrine that the ^{of cigarettes?} hazards of cigarette smoking are related
to the "tar" output ~~output~~? Attempting to analyze the
thinking of the proponents of this doctrine, I find ~~mainly~~
three kinds ~~of~~ on which it seems to me that they mainly
depend. The first is the kind of evidence provided by
epidemiological studies in which they try to relate
disease incidence to the level of exposure ^{total} to smoke, that
is, to the number of cigarettes smoked per day. We have
already discussed the difficulties in interpreting such
studies. In the present context I want to add the
point that the exposures they are talking about are
exposures to whole smoke with all its ingredients, whatever
conclusions ^{may be} ~~are~~ justified from such studies, any effects
claimed cannot be attributed ^{specifically} to "tar" any more than to

The second kind of evidence ~~that~~ on which the "tar" dogma apparently rests is the cellular abnormalities seen in the lungs of chronic smokers, in which these changes are presumed or not is a matter of intense debate among pathologists. We are trying to help resolve this question by ~~world~~ studies. The point here is that the subjects of this study breathe ~~whole~~ smoke and there is no evidence that the changes mentioned are attributable ~~specifically~~ to the particulate phase of smoke ^{which} is the principal component of "tar," ^{inhaled}

nicotine. If they are effects attributable to the smoke at all, they ~~cannot~~ ^{cannot} be assigned to any smoke fraction or ingredient unless or until there is some evidence to justify such assignment.

^{Third and chief}
 The ~~second~~ kind of evidence these proponents of the "tar" dogma are relying upon is the mouse-skin painting work. As I have said before, the trouble with this method is that it applies the wrong material, in the wrong form, in the wrong concentration, to the wrong tissue of the wrong animal to have any clear or simple relation to the human lung cancer problem. The condensates used in such studies do not contain all the ingredients of fresh, normal smoke. The physical form is entirely different from that of smoke. The skin is a very different kind of tissue from the lung, as shown by ~~extensive Council~~ ^{extensive Council} studies sponsored by the Council. And ~~we have shown~~ ^{Council-sponsored} studies have shown that pipe tobacco and cigar tobacco smoke condensates are as active in producing tumors on the skins of mice as cigarette smoke condensates, even though human pipe and cigar smokers rarely get lung cancer.

Unfortunately mice are also quite different from men or monkeys in their susceptibilities to cancer-producing chemicals.

We think that we will learn much more about the effects of tobacco smoke on lung tissue by making small animals inhale whole, fresh, normal ^{smokes} cigarette repeatedly over long periods, than by skin painting with condensates. It has been a difficult task to ~~design~~ ^{design} mechanical devices for bringing ~~them~~ ^{about} ~~about~~ ^{smoke inhalation} ~~about~~ ^{reproducing} conditions closely resembling human smoking conditions, ^{and to measure the actual dosage received,} ~~but~~ ^{we think} we are now ^{reasonably} close to being able to bring the right material, in the right form and the right concentration to the right tissue; though it is still ^{the wrong animal} ~~the wrong animal~~ ^{with earlier and cruder devices,} ~~in the past years,~~ ^{so far,} chronic exposures of this kind have not been followed by appearance of lung ^{cancers.} ~~tumors,~~ ^{It remains to be} other than a ~~very occasional one of the types that occur spontaneously~~ ^{in the} seen what will happen with ^{use of improved} ~~the known~~ equipment. If no cancers are obtained with ^{wide} a variety of animal species, ^{and} ~~with~~ ^{with} various kinds of conditionings to increase susceptibility, we will become increasingly doubtful whether tobacco smoke can act ^{on lung tissue} as a direct contact carcinogen. But this will not end the search. There are several methods by which lung cancers resembling the human type can be produced in animals. Using such models, a great variety of factors and influences can be screened to see how they affect susceptibility. Among these factors and influences, tobacco smoke can

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be studied in context to see whether it could play some kind of an indirect contributory role. And whether or not any contribution by tobacco ^{were} found, such studies ^{might well} ~~may lead~~ ^{This is our real objective and} up clues to the prevention of human lung cancer. ~~We~~ have mapped out a broad program of studies along such lines, and ~~would rejoice if the Government departments eventually see fit to help carry them out~~

On the other hand, if the animals exposed to inhalation of fresh, whole, normal smoke in the improved equipment should develop cancers of the lung, this result might come almost as a relief. For then it should be ^{possible} to make systematic studies of fractions of the smoke, ^{and} identify the responsible agent. Once identified, its removal or prevention should be ~~well~~ within the capability of our scientists. Then we might have a cigarette that we could feel quite sure was safe with respect to any cancer hazard.

It is a fortunate fact in scientific research, that a variety of different ^{and contrasting viewpoints} working hypothesis can all engender good research. The ^{eventually} results of good research can be expected to intermingle, interrelate and provide illumination as well as suggest, new and better hypotheses. We hope to continue and intensify our work along ^{such} ~~the~~ lines described ^{as have been} ~~and~~ ^{illustrated here tonight,} ~~with~~ ^{as an area that has been} ~~in~~ ^{to} Dr. Stewart, I would say that the door ~~is~~ ^{has} always ~~been~~ ^{remains} open to cooperation. It ~~is~~ ^{remains} open.