The Baker Lectures

1975

THE THIRTY BILLION DOLLAR PROBLEM

by John F. Finklea, M.D.

FOREWORD

Everyone wants clean air. Everyone wants to drive automobiles. Unfortunately, automobiles pollute.

However, a little gadget, known as a catalytic converter, will reduce the carbon monoxide and hydrocarbons, which automobiles produce. Alas, catalytic converters also convert sulfur dioxide, given off when sulfur containing gasoline is burned,to more irritant sulfuric acid and acid sulfates. Thus, a device to reduce one type of pollution increases another type. The final state may be worse than the first. Dr. Jack Finklea discusses this expensive problem in his fascinating and provocative lecture.

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THE 1975 BAKER LECTURE

T H E
T H I R T Y
B I L L I O N
D O L L A R
P R O B L E M

by JOHN F. FINKLEA, M.D.

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Under the Auspices of the Michigan Lung Association

JOHN F. FINKLEA, M.D.

The 1975 Henry Brooks Baker Lecture was presented by John F. Finklea, M.D., director of the National Institute for Occupational Safety and Health, U.S. Dept. of Health, Education and Welfare, Washington D.C. He was formerly the director of the National Environmental Research Center, Environmental Protection Agency, Research Triangle Park, North Carolina.

Dr. Finklea's academic appointments include: Teaching assistant in epidemiology at the University of Michigan School of Public Health, 1965; associate in medicine at Northwestern University Medical School,1966; assistant professor in preventive medicine and pediatrics at the Medical College of South Carolina, 1966-68; professor there in 1968-69; adjunct professor of epidemiology at the University of North Carolina, 1969; and assistant clinical professor of community health at Duke University Medical School in 1969.

Research appointments preceding his current position include: principal investigator, Clinical Trial of Tropical Chemotherapeutics; principal investigator,Clinical Trial of Purified Influenza Vaccine; project director, Community Health Teaching Enhancement and Community Health Apprenticeship program; project director, South Carolina Community Pesticide Studies; consulting epidemiologist, Streptococcal Disease Unit, Trinidad; chief, Ecological Research Branch, Division of Health Effects Research, National Air Pollution Control Administration and director of the Division of Health Effects Research.

Dr. Finklea is a member of the American Public Health Association, the American Medical Association, the American College of Preventive Medicine, the American Association of Teachers of Preventive Medicine, the American Society for Microbiology, and others.

Dr. Finklea received his medical education at various universities and colleges in the south and at the University of Michigan, Ann Arbor,Michigan.

INTRODUCTION

Let me thank the University of Michigan School of Public Health and the Michigan Lung Association for the opportunity to deliver the 1975 Baker Lecture and to focus your attention on a major public health issue. Let me also add a personal note of thanks to the faculty of this school and the professional staff of University Hospital. Any contributions to society that I may make can be traced to what they have given. It is also appropriate for the great grandson of a Confederate soldier who lay wounded at Petersburg to wonder what physician helped his forebearer survive. Could this physician have been Henry Brooks Baker? I do not know but one can be assured that Dr. Baker would be most interested in our efforts to protect public health through environmental controls. Regulatory actions based upon the need to protect public health will likely pose a number of multi-billion dollar problems like the one we discuss today: The control of sulfur oxides. In discussing this problem, the views which I express are my own and these views do not necessarily represent the policy of any federal agency.

The Clean Air Act amendments of 1970 recognized the need to protect the public health from any adverse health effects attributable to pollutants emitted from motor vehicles or from stationary sources including steam-electric power plants. The Act requires that health-related air quality standards be set to protect fully both health and especially susceptible segments of the population. Stringent limitations in carbon monoxide, hydrocarbon and nitrogen oxide emissions from vehicles were mandated for 1976. Health-related air quality standards for sulfur oxides and particulates, two of the most important pollutants emitted by steam-electric power plants, are scheduled to be met before the end of this decade. Meeting emission and air quality standards will prove a difficult challenge for an electric utility industry already facing other major obstacles in its efforts to meet the growing power demands of our nation. The most difficult standards to attain relate to sulfur oxides.

WHY CONTROL SULFUR OXIDES?

For at least another decade industrial nations will combust increasing quantities of fossil fuels that contain organic and inorganic sulfur compounds. Unless specifically controlled, the sulfur compounds in fossil fuels utilized by steam-electric power plants will be emitted into the air as sulfur dioxide and, to a lesser extent, as sulfur trioxide. These sulfur oxides are transformed in power plant plumes and later in the atmosphere into acid-sulfate aerosols (strong acids and sulfate salts) which are more potent irritants than sulfur dioxide. Acid-sulfate aerosols are fine particulates which have a long atmospheric residence and which are capable of penetrating deeply into the human respiratory tract where they may become entrapped. Acid-sulfate aerosols can adversely affect human health, vegetation, fish, materials, and visibility.

HOW ARE SULFUR OXIDES EMISSIONS CHANGING AND HOW ARE SULFUR DIOXIDE AND ACID SULFATE AEROSOL LEVELS CHANGING?

Two important concurrent changes in sulfur oxides emissions have taken place in recent years:

--*Urban emissions from area sources, industrial sources and power plants have decreased*
--*Suburban and rural emissions from steam-electric power plants have increased*

Urban emissions of sulfur oxides from home heating and industrial sources began to decrease just after World War II, and air pollution control efforts during the late 1960's only reinforced a trend that was already well established. Concern about urban air pollution did, however, cause a number of utilities to seek low sulfur fuels which have since become scarce and increasingly expensive. Precise estimates are not available but it is likely that sulfur oxide emissions in our major cities were decreased by about 50% between 1960 and 1970. Further reductions are envisioned under the state implementation plans required by the Clean Air Act amendments.

On the other hand,suburban and rural emissions of sulfur oxides rapidly increased between 1960 and 1970. This is in large part attributable to a continued growth in sulfur oxides emissions from steam-electric power plants. If emission standards and existing air quality standards are met, sulfur dioxide emissions from steam-electric power plants must be substantially reduced. The emission picture will be further complicated by the need to import significant quantities of high sulfur petroleum and utilize more high sulfur domestic coal. Continuation of recent growth rates in the generation of electricity by fossil-fuel steam-electric power plants could greatly increase emissions if continuous emissions controls are not installed on new plants or plants converting low sulfur fuels to high sulfur fuel. On the other hand, conservation measures and increasing utility rates can slow growth in demand and thus lessen the adverse effects of an unrestrained growth in emissions of sulfur oxides.

Sulfur dioxide is changed in the atmosphere to sulfur trioxide and sulfuric acid by a number of different complex mechanisms whose effective transformation rates vary greatly. The predominant mechanism can be expected to vary from place to place and over time. Sulfuric acid aerosols and the salts that form with ammonia or metallic cations may be transported for long distances. Urban acid-sulfate aerosols contain at least three components: First, a component intruding from rural sources and distant urban plumes; second, a component arising from sulfur oxide emissions in the urban area; and third, a component of natural origin. Acid-sulfate aerosols are removed by rainout and washout. Sulfur trioxide in smaller amounts is also emitted directly from combustion sources and is rapidly transformed into sulfuric acid aerosol.

Power plants in the eastern half of the United States are spatially arranged so that moving air parcels replenish their sulfur loading more rapidly than acid sulfate aerosols can be removed by natural processes. The increased acid-sulfate aerosol loading is associated with worrisome increases in atmospheric turbidity, rainfall acidity, and ambient air levels of suspended particulate sulfates in urban and rural areas. Water soluble suspended particulate sulfates collected on a high volume air sampler are a useful but imperfect proxy for acid-sulfate aerosols. Increased acid-sulfate aerosol loadings mean that ambient air entering downwind metropolitan regions may contain bothersome levels of pollutants even before emissions from the local air quality control region contribute a further increment.

A recent study by the National Academy of Sciences points out that power plants equipped with tall stacks can keep ground level sulfur dioxide within existing ambient air quality standards. However, emissions from power plants will then be transported for long distances mixed with other plumes and cause elevated ground levels of sulfuric acid and sulfide salts. Thus, tall stacks and intermittent controls offer no solution to the regional sulfate problem.

In eastern cities, fluctuations in sulfate levels can be more or less predicted from regional changes in sulfur oxide emissions. On the other hand, fluctuations in sulfur dioxide levels are rather directly related to local emissions of sulfur dioxide.

Pre-1975 light duty motor vehicles burned gasoline containing small amounts of sulfur and emitted sulfur dioxide--nationwide, cars accounted for less than one percent of sulfur dioxide emissions. Further, these emissions were diluted,dispersed and changed rather slowly into sulfuric acid and sulfates. Cars were then equipped with oxidation catalysts to reduce emissions of carbon monoxide and photochemical oxidants. Unfortunately, cars equipped with oxidation catalysts emit sulfuric acid directly, thus increasing exposure along busy expressways, in urban street canyons, and around complex sources like shopping centers and large airports. Sulfuric acid from catalyst equipped cars will be added to worrisome levels of acid-sulfate aerosols present in most of our cities.

WHAT ADVERSE EFFECTS ON HEALTH ARE EXPECTED?

Short-term exposures to elevated levels of sulfur oxides, especially acid-sulfate aerosols, are thought to aggravate asthma and pre-existing heart and lung disorders. Elevated short-term exposures to acid-sulfate aerosols are also likely to have been largely responsible for perceptible increases in daily mortality observed during air pollution episodes. Repeated short-term peak exposures or more even elevations in annual average exposures to acid-sulfate aerosols lasting several years are likely to result in excess acute lower respiratory disease in children, excess risk for chronic respiratory disease symptoms in adults, and decreased ventilatory function in children.

These effects were observed in community studies where levels of sulfur dioxide, acid-sulfate aerosols and suspended particulate matter were usually but not always simultaneously elevated. Unfortunately, it is only now becoming possible to develop laboratory animal models and clinical protocols that allow one to mount complementary studies on the effects of fine divided acid-sulfate aerosols on susceptible population segments. Earlier toxicology studies exposing healthy young adult animals for short periods to sulfur dioxide alone or to sulfur dioxide and particulate have shown equivocal results.

It is the best judgment of federal scientists working with this problem that measurable adverse health effects attributable to vehicles equipped with catalytic converters will occur along the busiest expressways after two or three model years. Adverse health effects in most cities with more than 100,000 population will be measurable after three to six model years.

MAJOR CONCLUSIONS

- --*Failure to control sulfur oxides emissions may well result in thousands of excess deaths and millions of excess illnesses.*
- --*Acid-sulfate aerosols represent a complex public health and regulatory problem.*
- --*Control of sulfur oxide emissions from urban and rural power plants will be required.*
- --*National policies dealing with economic growth, fuel choices, conservation practices and requirements for permanent emissions controls must be carefully coordinated.*
- --*It is our best judgment that massive conversion of urban power plants to high sulfur fuels and the use of tall stacks with supplementary control systems in rural power plants will greatly increase sulfate concentrations and endanger public health.*
- --*Equipping vehicles with oxidation catalysts for several model years will further aggravate the problem unless control measures are instituted.*
- --*Uncertainties in our scientific information base will foster major societal disagreements about the steps necessary to control the problem.*
- --*Scientific uncertainties are being reduced by research programs but important information gaps will remain for five to ten years.*

THE POSSIBLE COSTS

Control of the sulfur oxides problem involves billion dollar investments by consumers and by industry. Industry has probably invested around a billion dollars in catalytic converters. Consumers initially pay $150 to $200 per car for catalytic converters. Over a ten-year period consumers might be expected to invest seven to twenty billion dollars, depending on car sales and the proportion of vehicles that are equipped with catalysts. If desulfurization of gasoline proves necessary, the price of a gallon of gasoline might increase one or two cents and the petroleum companies might be forced to invest between three and twelve billion dollars.

Our nation may well choose to reduce its dependence on foreign oil and to utilize its reserves of high sulfur coal in conventional steam-electric power plants. In that case, utility companies might be required to invest three to nine billion dollars in flue gas desulfurization equipment. Such an investment and subsequent operating costs would, of course, be reflected in higher electric bills for the consumer. Overall, we are faced with a thirty billion dollar problem.

WHAT LEAD TIMES ARE REQUIRED TO MEET STRICT EMISSIONS STANDARDS AND SIMULTANEOUSLY CONTROL SULFURIC ACID EMISSIONS?

Sulfuric acid emissions from catalyst equipped cars might be controlled by the addition of more control hardware, like acid traps, to existing systems. This would take at least three years. Desulfurization of gasoline, another control measure, would also require more than three years. Wide-scale introduction of alternate engines that are cleaner and more economical would require four or more years. Since measurable increments in adverse health effects are projected when one or two more model years are catalyst equipped, time has run out.

A CHRONOLOGY OF THE THIRTY BILLION DOLLAR PROBLEM

When trying to resolve a major problem and studying a problem to avoid past mistakes in the future, a chronological approach can prove instructive.

A CHRONOLOGY OF THE THIRTY BILLION DOLLAR QUESTION

Mid 19th Century	Sulfuric acid produced by catalytic conversion of sulfur dioxide.
Early 20th Century	Sulfur content of petroleum and petroleum products quantified.
Late 1950's	Sulfuric acid and sulfates shown to be respiratory irritants.
Mid 1960's	Catalytic converters proposed to control carbon monoxide and hydrocarbons.

Mid 1960's	Concern expressed about thermal hazards and emissions attributable to catalysts.
1970	Clean Air Act amendments mandated stringent emissions standards and required that control devices not emit new or harmful pollutants.
1971	Automotive companies invested in catalysts as show of good faith to obtain delay in meeting emissions standards.
Winter 1972	Federal scientists expressed concern and urged research program to assess unregulated emissions attributable to changes in fuels, fuel additives, lubricants, automotive power plants and emission control systems, sulfuric acid specifically mentioned.
Spring 1972	Auto and petroleum companies urged to join federal government in investigation of unregulated emissions.
Summer 1972	Epidemiologic studies linked "sulfates" to a variety of adverse effects on health.
January 1973	Auto company alerted federal regulatory agency that oxidation catalysts produce particulate sulfates and sulfuric acid.
Winter 1973	Emissions standards for 1975 required use of oxidation catalysts in California. Auto companies choose to apply them nationwide.
Spring 1973	Congressional staffs alerted to unregulated emissions problems.
Summer 1973	Oil company better characterized sulfuric acid emissions from oxidation catalysts. Federally funded program to investigate unregulated emissions established.
Fall 1973	Scientific advisory committees, Office of Management and Budget, and National Academy of Sciences briefed on the problem.
Fall 1973	Public health impact of oxidation catalysts projected and regulatory agency urged to delay introduction until safety is assured. Open dissension erupts within the federal regulatory agency. Agency rules sulfuric acid not a new or dangerous pollutant.

November 1973	During Senate hearings the responsible federal official announced introduction of catalysts for two model years and accelerated research program to quantify any hazards.
April 1974	Federal scientific conference confirmed sulfuric acid exposure problem and relates power plant and automotive emissions.
April 1974	Federal Energy Agency administrator briefed.
September 1974	Federal Power Commission briefed.
Fall 1974	Congressional committee requested public health risk-benefit assessment. National Academy of Sciences asked to review power plant and catalyst contributions to "sulfuric acid-sulfate" problem. Science Advisory Board of Regulatory Agency reviewed problem.
Early 1975	Benefit-risk estimates completed. Projections relating power plant and catalyst emissions completed. Federal research scientists labeled continued use of catalysts a public health risk. Regulatory agency conducted open hearings.
March 1975	Regulatory agency announced continued use of oxidation catalysts for four years but pledged to control sulfuric acid emissions. Policy reviews conducted by the Executive Branch and hearings by both Houses of the Congress.
March 1977	Measurable adverse health effects in largest cities likely during 1977 model year.

WHAT CHOICES DO WE HAVE?

There are at least three major alternatives available to deal with the sulfuric acid problem. No alternative seems entirely satisfactory. First, one can continue the use of catalysts and use other measures to reduce sulfuric acid exposures. Because the time available to implement such a strategy seems so short, some public health risk seems likely. American industry would be affected in a complex manner: Catalyst producers would be protected and utility companies might be faced with more stringent controls, oil companies might be asked to desulfurize gasoline. The American public, after seeing that mobile source emissions controls result in a net public health risk, might choose not to support federal regulatory programs.

A second choice is to discontinue catalysts, set emissions standards less stringent than 1975 levels and require future introduction of inherently cleaner engines. From a public health point of view, this is the safest course. However, there are major obstacles to such a decision: The Clean Air Act would have to be amended and the development of inherently cleaner engines would require either a legislative mandate or a "good faith" effort by manufacturers. Prohibition of catalysts might inhibit industry from making additional future investments in control technology.

A third choice is to utilize "cycle beating." In this "technique," the test cycle is adjusted to the point at which the problem vanishes. Alteration of test cycles in the past had the effect of relaxing emissions control requirements. As a corollary to this strategy, one could minimize estimates of future sulfuric acid emissions by ignoring future increases in the sulfur content of nonleaded gasoline which will equilibrate at levels two to three times those currently found. "Cycle beating" would trade a public health risk for an apparently satisfactory "solution." "Cycle beating" would not disturb consumer costs, affect existing capital investments or require large new investments. Unfortunately, "cycle beating" would only postpone the day when hard decisions are required.

WHAT IS THE PUBLIC HEALTH IMPACT OF ALTERNATE EMISSIONS STANDARDS?

Stringent emissions controls are desirable for Southern California; elsewhere clean, safe emissions controls are required for the long term to allow for expected growth. However, for the next three or four model years there would be little, if any, measurable effect on air quality and no difference in health effects should any of several different emissions scenarios be adopted. More specifically, the emissions standards currently being recommended by the responsible federal regulatory agency for the next four model years will achieve nothing in the way of health protection that could not be obtained by leaving standards at or near the 1974 level. However, current recommendations will assure increasing exposures to sulfuric acid. Hopefully, current reviews by the Executive and Legislative Branches can prevent such a tragedy.

THE LESSONS

Several important lessons should be apparent from the preceding discussion:

- --*Regulatory actions must be soundly based scientifically if major errors are to be avoided.*
- --*Redundancy is required to insure success. Several mobile source control technologies should have been simultaneously developed.*

--Major problems persist longer than the tenure of major decision makers. The latter are likely to serve at most 2 to 4 years while major problems stretch over a decade or more.

--Faulty decision making can be very expensive.

POINTS FOR ACTION

There are a number of ways by which voluntary health organizations can act to make the government--be it at the local, state, or federal level--more responsive.

First, state and federal governments need your advice even if they don't always seem to listen. There is no doubt that the health professions, the American public and governmental bodies have responded to your messages in the past. Second, you should recruit and suggest qualified candidates for the scientific advisory committees serving industry and all levels of government. Third, inform yourselves about appointive vacancies, and have your thoughts in order about what kind of person would best serve our citizens. Then influence these appointments through your contacts with government. Fourth, establish your own expert committees and request the opportunity to review proposed regulatory actions which are health-related. Fifth, inform yourselves of advisory committee meetings and request minutes of those meetings for use by your own expert committees. Sixth, offer to host public hearings or meetings of advisory committees in conjunction with a meeting of your own organization. Encourage informed and affected members of the public to be present at those meetings. I have seen many attorneys representing legitimate industrial interests and a number of reporters at advisory committee meetings. Rarely have I encountered representatives of professional societies or voluntary health organizations and never have I seen someone representing elderly persons with cardio-respiratory illness or asthmatic children. Seventh, establish a mechanism to assure that you have access to scientific information developed by government laboratories and make sure this mechanism is unrelentingly vigilant. While you are so occupied, have a look into how proprietary information affecting the public health can be made available to all interested groups. Eighth, sponsor training sessions for citizens and health professions so that they may better serve on your expert groups, on advisory committees, and as unbiased experts during adversary proceedings. It may be difficult for you to get funding from the federal government for this purpose, but you can easily command the participation of government scientists at little or no cost to yourselves. Ninth, sponsor open scientific exchanges involving adversaries and unbiased scientists and citizens. Tenth, work with your friends in the legal profession towards innovative mechanisms which assure unbiased scientific inputs into adversary proceedings. Eleventh, sponsor or participate in needed health-research efforts. This may take a number of different forms. You can directly fund health-research projects without outside participation. You can request joint arrangements whereby federal scientists assist you in your review of applications for research support. You can participate in needed health research directly. The citizen surveys of the American Cancer Society were, for example, very helpful in our emerging understanding of factors that contribute to an increased risk of lung cancer. Twelfth, you should continue to inform the public in a responsible fashion about what needs to be done to protect public health.

IS IT WORTHWHILE?

The steps previously listed and others that you might institute will undoubtedly require a great deal of continuing effort and interaction with those whom you might now be strangers. Is it worth the effort? My answer is an unequivocal YES. The decisions you will be influencing are multi-billion dollar decisions that will have a perceptible effect on everyone's life. In fact, you may be among those best equipped to help your government understand what is doable. Your organizational experience in the fight against tuberculosis and respiratory illnesses showed what is required to motivate citizens to make that complex sequence of individual decisions required to protect an individual's health. You already know how difficult it is to try to change one's life style. What changes in life style are acceptable to achieve environmental goals? In my opinion, folks working in Washington offices or federal laboratories aren't likely to give the best answer to that question without better inputs from people such as yourselves.

You are also well qualified to represent the interests of that five to ten percent of the population known to be most susceptible to adverse effects caused by air pollution. You have long been their advocate and your experience will lend a needed human perspective to the issues that face us today. Bureaucracies may be technically informed but they sure don't seem very human.

Let me close by again thanking you for the opportunity to share my thoughts with you. I hope that the perspective will prove helpful.

HENRY BROOKS BAKER, M.D.

Henry Brooks Baker, like Oliver Wendell Holmes, Jr., was a Yankee from Olympus. He was born in Vermont and came to Michigan as a boy of 12 in tow of his stepfather. He lived first in the Bunker Hill area of Ingham County, then in Mason, and later in Lansing.

As a youth, he began the study of medicine under a preceptor, Dr. Ira Hawley Bartholomew, of Lansing. The Civil War began and the youthful apprentice to the medical profession enlisted in the 20th Michigan Regiment as a hospital steward. The young Baker went almost at once to the front and quickly earned his commission as an assistant surgeon.

He toiled in the operating arenas at the battles of Fredericksburg, Petersburg, Cold Harbor and at the siege of Vicksburg. He was in action against Morgan's Raiders at Horseshoe Bend on the Cumberland. In the Battle of the Wilderness, he was captured by men of Chambliss' Brigade of Steward's calvary, and paroled.

Henry Baker returned to civil life with fervor for preventive medicine. He augmented earlier studies at the University of Michigan by attending Bellevue, from which he was graduated in 1866. He collected mortality statistics. He was one of the first to use services of information to inspire progress toward prevention and control of diseases. Largely through Dr. Baker's efforts,the Michigan State Board of Health was established 100 years ago in 1873. Dr. Baker became its first secretary and so served until 1905.

Dr. Baker clamored with skin-deep gentility for those basic controls over tuberculosis which today are so vital in maintaining surveillance. He told the people that children might "catch" tuberculosis from the milk of infected cattle--back when Theobold Smith, hero of the conquest of bovine tuberculosis, was still an undergraduate in Cornell College of Medicine. Most importantly, however, Dr. Baker was instrumental in having tuberculosis recognized as a reportable disease by resolution of the State Board of Health on September 30, 1893, thereby setting a shining precedent. An old soldier, intransigent and intuitive like Pasteur, Virchow, and Koch, yet scientific, too (he was a voluminous writer of learned papers), Dr. Baker was one of the great. He was one of the founders of the National Tuberculosis Association.

Not in laurels that fade, nor in marble halls that are cold and lifeless, lies the full expression of fame. It is more truly recorded and perpetuated in those benefits to humanity which live on and have a continuing vital force. What Dr. Baker did in the effort to conquer tuberculosis is his true memorial.

THE BAKER LECTURES

The annual Michigan Lung Association lectures were instituted in 1948 at the School of Public Health, University of Michigan. In 1952, these lectures became known officially as the Henry Brooks Baker Memorial Lectures in honor of Michigan's great pioneer in public health.

1948: "The Place of the Non-Official Tuberculosis Association in the Public Health Movement," George J. Nelbach, LL.B.

1949: "The Voluntary Health Agency in the American Scheme," C.W. Kammeier, Executive Secretary, Wisconsin Anti-Tuberculosis Association

1950: "Obstacles to the Eradication of Tuberculosis," James E. Perkins, MD, Director, National Tuberculosis Association

1951: "Tuberculosis: Whose Responsibility?" Kenneth W. Grimley, Executive Secretary, Alabama Tuberculosis Association

1952: "The Force of Voluntary Organization in Tuberculosis Control," Esmond R. Long, MD, Director, Henry Phipps Institute

1953: "Through the Looking Glass," Mark H. Harrington, President, National Tuberculosis Association

1954: "Mental Health in the Tuberculosis Program," Frank E. Coburn, MD, Associate Professor of Psychiatry, State University of Iowa

1955: "Getting Things Done--the Voluntary Association in the Control of Tuberculosis," Robert J. Anderson, MD, U.S. Department of Health, Education, and Welfare

1956: "The Courage to Carry On," Herbert R. Edwards, MD, Associate Professor of Public Health, Yale University

1957: "A Volunteer in Public Health," Theodore J. Werle, Executive Secretary Emeritus, Michigan Tuberculosis Association

1958: "The Challenges of Tuberculosis," Henry Stuart Willis, MD, Superintendent-Medical Director, North Carolina Sanatorium System

1959: "Interagency Cooperation in the Detection of Tuberculosis," Paul T. Chapman, MD, Tuberculosis Controller for Detroit and Wayne County

1960: "What's Past Is Prologue," R. Winfield Smith, Executive Director, Pennsylvania Tuberculosis and Health Society

1961: "Evolution of Concepts in the Prevention of Tuberculosis," Rene Jules Dubos, Professor of the Rockefeller Institute

1962: "The Magnetism of Excellence," John B. Barnwell, MD

1963: "Tuberculosis--A World Problem," George J. Wherrett, MD, Executive Secretary Emeritus, Canadian Tuberculosis Association

1964: "Curing and Learning: 100 Years of Sanatoriums," Julius L. Wilson, MD, former Director of Medical Education for the American Thoracic Society

1965: *"Some New Tools for Tuberculosis Workers," N. Conant Webb, Jr., MD, New Jersey College of Medicine

1966: "The Tuberculin Test: In Retrospect and Prospect," Carroll E.Palmer, MD, and Lydia B. Edwards, MD, Tuberculosis Program, U.S. Public Health Service

1967: "Chemoprophylaxis for the Prevention of Tuberculosis," Gordon M. Meade, MD, Director of Medical Education, American Thoracic Soc.

1968: "Atmosphere As A Biological Medium," John S. Chapman, MD, Assistant Dean for Postgraduate Education, University of Texas Southwestern Medical School, Dallas

1969: "Tuberculosis Control--A Paradox For Global Public Health," Edward J. O'Brien, Executive Vice-President of the Ontario Tuberculosis and Respiratory Disease Association, Toronto, Ontario, Canada

1970: *"Primary Care and Primary Prevention," David J. Sencer, MD, Director of the Center for Disease Control, U.S. Public Health Service, Atlanta, Georgia

1971: "Health Education and Medical Care," Guy W. Steuart, PhD, Professor and Head of Health Education, School of Public Health, Univ. of North Carolina at Chapel Hill

1972: "The Inter-relations of Tuberculosis in Man and Animal, Past, Present and Future," W. L. Mallmann, PhD, and Virginia H. Mallmann, PhD, Michigan State University, East Lansing, Michigan

1973: "Compensation for Industrial Lung Diseases," William Keith C.Morgan, MD, Director of the National Environmental Research Center, Environmental Protection Agency, Research Triangle Park, North Carolina

* Lecture not printed

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