Progress of American Industrial Medicine in the First Half of the Twentieth Century*

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At the dawn of the 20th century, American industrial medicine was in its embryonic stage. Only a few hazardous occupations, all due to necessity and location, such as railroading, mining, and lumbering, employed physicians, primarily for the care of traumatic injuries resulting from accidents.

Some of these early American pioneer physicians were real humanitarians and progressive investigators who recognized the inadequate medical service provided, the abuses, the lack of compensation claims, the bad working conditions, and unsanitary environment. Due to their efforts and with the aid of public-spirited laymen they resorted to publicity with the design of having these evils corrected. As a result of these measures, preventive medicine, public health, sanitation, safety, health education, and workmen's compensation laws became integrated with modern curative medicine, all of which culminated in the specialty of industrial medicine.

During the interim medical education made tremendous advances, largely due to Pasteur's and Koch's discoveries of the etiology of infectious diseases being due to organisms—this knowledge contributing to the advance of modern surgery, public health, and preventive medicine. Synthetic and biochemistry progressed at such an amazing pace that the chemical age was developed almost simultaneously. The physical sciences, through the medium of research, developed mechanical engineering, utilizing electrical energy for power, illumination, and communication. Thus began a new era—the "American Industrial Renaissance"—which stimulated research, invention, and developed new trades and technologies in every field of endeavor.

The American pioneer industrial physicians profited from the discovery and publications of European physicians, scientists, and sociologists whose contributions were largely in the field of occupational medicine, especially during the 19th century when the

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machine age followed Watt's discovery of the steam engine.

Historically, England, as the outcome of the industrial revolution, founded modern public health and industrial hygiene. She created laws for the working people, many of which were adopted into state laws in the United States. We are indebted to that country which produced George Baker, James Lind, Percival Potts, Humphrey Davy, C. T. Thackrah, Florence Nightingale, et al.

France gave the world Pasteur, Rayer, Davaine, Tanqueral des Planches, Merat, and the Curies.

Germany before World War I was preëminent in the fields of chemistry, pathology, and technology. She gave the world two immortals: Robert Koch and Wilhelm Konrad Röntgen.

Italy, distinguished in somatic medicine, revealed to the world the science of human anatomy—Bernardini Ramazzini, father of industrial medicine; Dubini, discoverer of the hookworm, and Luigi Devoto, founder of the first occupational clinic.

Other countries made discoveries of great importance to which American industrial medicine recognizes and justly pays tribute.

The inspiration that gave impetus to the United States, ultimately to become the leading technological country in the world, was the development of the Bessemer process in steel manufacturing, so essential for mechanical fabrication. The invention of the internal combustion gas engine applied to transportation made possible the creation of the automobile and airplane. America was geographically fortunate in possessing vast supplies of raw material, such as oil, metals, forest, and farm products. Our universities and technical schools trained and furnished skilled engineers, technicians, inventors, and business executives who developed the major and minor engineering techniques necessary to build the modern automobile. In turn, this meant expansion into hundreds of industries to supply the accessories necessary to produce and operate the automobile, such as rubber tires, batteries, electric motors, lighting, enamels, and other gadgets for the safety and comfort of motorists. The automobile industry—including as it does small business ventures, such as garages, gas stations, parking facilities, motels, and thousands of miles of road construction, and improvements in town planning—provides employment for millions of our population.

In the manufacture of the raw materials and in the fabrication of the automobile alone many occupational diseases resulted, viz., heat exhaustion, asphyxiation by gases, burns, traumatism, pneumoconiosis, and the ever-increasing metallic and solvent toxemias. The oil industry, from the well to the refinery, produces thousands of by-products, such as petrol, paraffin, oils, solvents, greases, dyes, pigments, insecticides, and pharmaceuticals. All of these are potentially toxic and some are carcinogenic; all affect the physiology of man and require the constant devotion of advanced clinical knowledge, engineering, chemical laboratory research, etc.

Thus, the chemical and physical factors causing occupational diseases and traumatism, and displaying the same symptoms as are observed in infectious diseases, had to be differentiated, diagnosed, and prevented by epidemiological procedures. The physician engaged in the plant recognizes the earliest signs of morbidity while it is curable and so prevents advanced pathology with all the consequences it entails. The fine training involved in the recognition of these symptoms and of the industrial hazards encountered has produced a new medical specialty in which curative and preventive medicine are unified—that is, industrial medicine and the modern industrial physician.
The writer of this article was persuaded, after 52 years of practice as an industrial physician and a university professor in occupational hygiene, to make a chronological review from his own experience and observations on the advancement in this important field of medicine. During the two decades prior to 1900 there were only 22 contributions made to this literature by American authors, and those that were obtainable were more or less on sociological problems devoted to the subject of the economic losses and wastes in industry arising from poor health conditions, environmental working conditions, lack of sanitation, safety, compensation laws, and especially the absence of humanizing elements of industry. Yet, it was these early publications that promoted investigations which brought about corrective legislation and stimulated interest in public health, preventive medicine, safety, and the application of the newer developments in curative medicine and surgery. There were no journals or societies devoted to industrial medicine. Osler's textbook on medicine listed two occupational diseases: lead and arsenical poisoning. One could count on the fingers of one hand the number of books published on hygiene and sanitation. The great railroads were the first to operate hospitals for their sick and injured employees. It was the staffs of these hospitals who organized the American Association of Railroad Surgeons, at whose annual meetings were discussed the problems of traumatic surgery, safety, and sanitation.

FIRST DECADE—1900 TO 1910

The old maxim that necessity is the mother of invention held good in this early period when practitioners of general medicine were seeking the truth by means of survey, clinical observation, and research in the cause of an occupational health program, namely for the prevention of diseases and accidents and for the development of other sociological methods to improve working conditions and compensation laws.

The author introduced graduate nursing into the lumber industry. He trained and organized first aids in camps and mills; built a modern surgical hospital for major surgery; introduced the first x-ray coil, and published the first paper on abdominal injuries resulting from lumbering hazards. C.-E. A. Winslow gave the first instruction at the Massachusetts Institute of Technology in industrial hygiene.

In the field of occupational diseases caused by exposure to chemicals, George de Schweinitz, a Philadelphia ophthalmologist, observed that wood alcohol caused amblyopia. He later described laryngeal palsy due to lead intoxication. George E. Ebright of California at the Hercules Powder Works observed the “ether jags” resulting from making smokeless powder.

The most important event in the history of American industrial medicine at the close of the first decade was the report of the Wainwright Commission of New York. The report showed that only one out of every eight injured men was awarded compensation, and only 36.4 per cent of these were premiums. The balance of the funds were expended on claims adjusters, legal advice, and commissions. Recognition of this shocking condition was instrumental in the passage in 1910 of the first workingman's compensation law in the State of New York.

Prior to the passage of this law there were three common law defenses: contributory negligence, the fellow-servant clause, and the assumption of risk. The change from the doctrine of the employer's liability to the principles of workingman's compensation regardless of fault was not an evolution but a revolution. The economic burden of the injury is shifted from the individual to
employment and to society by charging it to the cost of production.


SECOND DECADE—1910 TO 1920

This decade opened up like spring. The physical sciences of electricity and engineering, together with synthetic chemistry, developed new processes and discoveries, and one out of every five of these developed hazards that produced morbidity and mortality. The top early investigators were humanitarians learned in their special sciences; they by their surveys and published reports made history in industrial hygiene. These were: Dr. John B. Andrews of the American Association of Labor Legislation who published his conference on industrial diseases and secured a Congressional law to abolish the phosphorous match, thereby preventing any more cases of phossy jaw; Dr. George M. Kober, distinguished professor of hygiene, author and leader in preventive medicine and industrial hygiene, made his contributions for social betterment; Dr. Alice Hamilton, a real explorer of the dangerous trades, a sociologist, toxicologist, and teacher, eminent in industrial health; Dr. Emery R. Hayhurst, illustrious research contributor, author, and organizer in occupational health. Their great efforts paved the way for others to follow.

In 1912, Dr. G. M. Kober presided at the Fifteenth International Congress on Hygiene and Demography held in Washington. In the section devoted to the hygiene of occupation there were 64 contributions by experts, covering all phases of the subject. At this meeting was laid the foundation for a scientific literature in American industrial medicine.

Two years later the American Public Health Association instituted a section on Industrial Hygiene at the Jacksonville, Fla., meeting. A special symposium of four papers on industrial hygiene was presented by Drs. Kober, E. R. Hayhurst, John B. Andrews, and C. T. Graham Rogers. At this same meeting 16 other papers offered by prominent persons were read and discussed. There the American Public Health Association committees served to advance the foremost researches on anthrax and benzo.

The dusty trades hazard is one of the most important causes of industrial morbidity and mortality, especially in the case of breathing air containing silica (SiO₂) producing silicosis—a lung disease characterized anatomically by generalized fibrotic changes, development of nodulation in the parenchyma of both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, coughing, unaccompanied by fever, increased susceptibility to tuberculosis, and by characteristic x-ray findings. We owe much credit to the Miners Phthisis Commission at Johannesburg, South Africa, for their monumental researches, including physical, chemical, roentgen, and autopsy findings. They demonstrated that from 0.5 to 5μ particles gain access to the lung structure through the endothelial cells lining the air vesicles. It is these cells that engulf the particles which are carried into the lymph channels where they become encapsulated and ultimately fibrogressed in the lung structure.

This work inspired American investigators who added by their researches to the literature important knowledge on silicosis and other forms of pneumoconiosis. These were: A. J. Lanza and S.
B. Childs, C.-E. A. Winslow and L. Greenburg, LeRoy U. Gardner, R. T. Legge, and Esther Rosencrantz, and many others. The studies by these investigators on the dusty trades led to means of dust prevention by the mechanical exhausts, the wet processes, the electric dust collectors, the impingers, and the konimeters for estimating dust particles in atmospheres.

Probably the most ancient industry is mining and the hazards have always been tremendous in this line of work. The U. S. Bureau of Mines developed important chemical tests, detectors, and methods of analyzing mine gases, as well as using the geophone to locate entombed miners, improving the technics of artificial resuscitation using oxygen and CO₂, gas masks, and training teams for mine rescue operations.

During World War I, from 1914 to 1918, some of the following researches were developed by and later used in industrial medicine:

Carrel-Dakin treatment of wounds with dichloramine T
Organization; methods for poisonous gas defense
Geophone to detect sappers underground
U. S. Army organized and promoted aviation medicine
American Commission investigated trench fever
Preventive inoculation against tetanus in gunshot wounds
Inoculation against typhoid fever in the Army and Navy
Rehabilitation for war cripples
Encephalitis recognized as a complication in pandemic influenza
Fatigue studies and researches in efficiency

The National Safety Council was organized to promote safety devices, accident prevention, careful statistics, surveys, and safety education. This was monumental pioneering in success-fully exploring the cause and prevention of accidents.

The American College of Surgeons, Committee on Industrial Medicine and Traumatic Surgery, adopted the minimum standard for medical service in industry, especially in the care of fractures, and later established a system of certification for industrial plants that met their requirements of standardization. This national association has had much influence on modern industrial surgery.

The most significant impetus to American industrial medicine, in fact, a crowning event, was the organization of the American Association of Industrial Physicians and Surgeons, the purpose of which was to elevate the standards of industrial medical practice; develop a code of ethics; promote industrial hygiene education and research, preventive medicine and safety, and to hold annual meetings for the advancement of industrial medicine.

During this decade the U. S. Government created the Bureau of Mines and a Division of Industrial Hygiene in the U. S. Public Health Service. Courses of instruction in industrial health in our universities and occupational clinics were established. Harvard University was the first institution to offer a course of instruction leading to a degree in industrial hygiene. The first professional periodical, The Journal of Industrial Hygiene, appeared. Statistics in industrial mortality and Louis I. Dublin’s Causes of Death by Occupa-tions were published. Surveys of fatigue and efficiency were made and a safety code for lighting factories developed. Commissions were appointed for investigation of ventilation, noise, and industrial wastes.

THIRD DECADE—1920 TO 1930

At the end of the second decade a new era was ushered in, especially in lead poisoning, the first ancient occupa-
tional disease. Previously, the published works of Tanqueral, the great French investigator, contained all that was known about the subject before him and in the 19th century as well.

Dr. Alice Hamilton, America's first distinguished woman physician, sociologist, toxicologist, and investigator in occupational diseases, earned honor and distinction by her researches into the problems of lead poisoning. Through her devoted and tireless surveys and researches in the principal lead industries she laid down the principles of preventive medicine as applied to industry. Her governmental surveys in the white lead, pottery, and printing trades are classic monographs which inspired the beginning of many reforms, including changes in the manufacture of lead products to protect the workers, and the introduction of medical examinations and compensation legislation. It was through her efforts that a manufacturer of white lead was induced to endow a research project at Harvard University on the action of lead in the human body. This made possible the distinguished studies of lead poisoning by Dr. Jacob Aub and his colleagues. Dr. Hamilton became the first woman professor at Harvard University and an author of a number of distinguished books and monographs in the field of industrial hygiene.

The lead poisoning researches at Harvard University regarding the manner in which lead is absorbed, transported, excreted, and stored in the body were brought to light through the scientific research conducted by Dr. Jacob C. Aub and his colleagues, L. T. Fairchild, A. S. Minot, and Paul Reznikoff. These investigators conclusively proved that lead entering the respiratory tract produces an effect more rapidly and severely than when it enters the gastrointestinal tract. They have also shown in a summary of the behavior of lead compounds from a physicochemical standpoint, that the products of the reaction between secondary sodium phosphate and a lead salt are tertiary lead phosphate and acid. This lead salt is very stable at normal hydrogen ion concentration of the body but sensitive to slight changes in acidity, passing into a more soluble di-lead readily. It is well known that the marked solubility of lead or its oxide, as in blood plasma, may account for the high incidence of plumbism after exposure to lead fumes or dust.

It was these same authorities who explained that lead was transported in the blood stream as colloidal lead phosphate and deposited in the bones as tertiary lead phosphate. These researches offer methods of deleading in the therapy of lead poisoning and the adoption of standards of safety in work shops to lead exposure limits, such as 1.5 mg. per 10 meters of air.

These were followed later by the brilliant researches of Robert H. Kehoe of the University of Cincinnati, one of the most distinguished American investigators in the field of lead diseases, famed for his painstaking laboratory researches in the physiology and toxicology of lead absorption and lead poisoning—the two manifestations which he clearly differentiated. The evidence of occupational lead absorption is possible to determine by the environmental degree of the hazard, of a survey of materials, and the activities of an industrial plant by estimating the lead content of the atmosphere of work spaces. Thus, the physiological evidences of lead absorption above the normal level can be clearly understood. This is a very important factor in industrial hygiene, general medicine, and medicolegal practice.

The earliest sign of lead absorption is specific for lead alone and is found in an increased rate of urinary lead secretions. The urine test is the most preeminent diagnostic method. According
to Kehoe lead is found normally in urine in quantities varying from 0.03 mg. to 0.08 mg. per liter of urine, with a mean concentration slightly in excess of 0.03 mg., and in the blood normally 0.03 mg. per 100 gr. This proves that a healthy American ingests normally with his food and drink a certain amount of lead which is eliminated by the alimentary canal and kidneys, and it is only when exposed to higher concentrations that the lead excretions increase. To summarize his brilliant researches it became imperative to differentiate harmless lead absorption from lead intoxication. The latter is based upon a lasting or significant lead exposure, the presence of an illness, consistent with known clinical manifestations, and certain corroborative laboratory findings.

Among other American researchers in the field of plumbism to whom credit is due for their contributions are: Carey P. McCord, May R. Mayers, Emery R. Hayhurst, Elsten L. Belknap, W. C. Dressen, and the APHA Committee on Occupational Lead Exposure and Intoxication.

FOURTH AND FIFTH DECADES—
1930 TO 1950

The score of years that followed from 1930 to 1950 registered continued progress and expansion in new fields of research and in legislative regulations introduced to protect the health and safety of employees. State medical societies organized medical care plans for group insurance; the federal government, in an endeavor to evaluate problems of industrial health, developed formulae and statistics to determine morbidity and mortality rates, classification of hazards, and compensation insurance. Credit is awarded for these important data contributed by the National Health Survey, the Census Bureau, W. M. Gafafer, Louis I. Dublin, C. O. Sappington, and J. J. Bloomfield. The American Medical Association, after long consideration, finally instituted the Council of Industrial Health in 1937. Its purpose was to coordinate problems in medical practice and industrial health. It now sponsors an excellent annual congress. Its membership is selected from the foremost men in industrial medicine who have made distinguished contributions in practice, research, and education. It publishes the Archives of Industrial Hygiene and Occupational Medicine.

Many national and state organizations which have direct association with industrial health have been created. These include the National Organization for Public Health Nursing, with an industrial nurses’ section; Industrial Hygiene Foundation; National Defense Council; United Mine Workers of America Welfare and Retirement Fund which provides for paraplegic miners. The U. S. Public Health Service established a Division of Industrial Hygiene. Among other groups organized during this period were: The American Industrial Hygiene Association, the American Association of Industrial Dentists, and the American Association of Industrial Nurses. All of these organizations have improved the standards of practice, and have made valuable contributions to industrial health.

Some of the distinguished researches contributed during this epoch were the investigation as to the causes of some 20 deaths among watch dial painters in New Jersey. The responsible agent was a radium paint. The U. S. Public Health Service outlined methods of control. There were extensive studies of beryllium intoxication as to symptoms, pathology, and therapy. Important researches are being continued in air pollution, especially in industrial cities, in regard to the cause of the agents producing so-called “smogs.” The carcinogenic agent that produces cancer, found in soot, tars, paraffin, aniline,
and mineral oil has been incriminated and isolated by Dr. George Gehrmann of the E. I. du Pont de Nemours Company laboratories as beta-naphthylamine. By means of physiological research the problems of prevention and treatment of heat stroke and exhaustion have been solved by the introduction of salt and glucose by Shoudy and R. Schofield.

With the advent of World War II, American and British scientists sought by extensive researches to develop an antidote for Lewisite, a deadly arsenical war gas. The British discovered the secret in B.A.L. For delousing, DDT became the answer. The sulfa drugs and antibiotics were developed. The atomic bomb and radio isotopes were produced. Use of plasma for shock and researches in the therapy of burns have advanced. Marked advancements have been made in surgery and prosthesis for amputees in war and industry. Astonishing results in modern rehabilitation have been made by H. H. Kessler and H. A. Rusk, and through preplacement examinations to determine a man’s capacities, and by job analysis to supply jobs for the handicapped through the work and researches of Kuh and Hanman.

The historical review of a half-century of American industrial medicine as witnessed by the writer presents a cross-index of the principal accomplishments that produced the specialty of industrial medicine and hygiene and developed three other professions: the industrial dentist, hygienist, and nurse. All fit in an ethical team by cooperation in the interest of the health and welfare of the American worker.

What is in store for industrial medicine in the next fifty years?

With the constant developments and new discoveries in synthetic and physical chemistry, our profession must be constantly alert to solve and combat by substitution other toxic substances as we did in the past.

The atomic age is now upon us—a new era in radioactive elements. The toxic effects on the physiology of man are to be studied and combated by preventive measures. This is industrial medicine’s challenge for tomorrow—and it will not be found wanting.

Occupational Medicine Series

Columbia University School of Public Health announces a series of one-hour lectures on Occupational Medicine to be given on 13 consecutive Saturday mornings beginning on September 20, 1952. The lecturers will be members of the staff of the Division of Occupational Medicine of the School. Interested members of the medical and allied professions are invited to attend. There will be no formal registration and no tuition fee. Nine a.m. in Amphitheater A, College of Physicians and Surgeons, 630 W. 168th St., New York 32.