



Mayo Clinic Contributions to Medicine: 150 for the 150th



Two Mayo Clinic pioneers received the 1950 Nobel Prize in Physiology or Medicine for their discovery of cortisone.

One of the most frequent questions during the Mayo Clinic Sesquicentennial was, “What are Mayo’s significant accomplishments?” Pursuing this topic, we realized that while there are many timelines related to Mayo’s history, a comprehensive compilation of Mayo’s distinctive contributions had never been assembled. To meet this need, we studied existing information and surveyed Mayo’s departments and work groups. Senior leaders and subject matter specialists reviewed submissions and prepared the following report.

With Mayo Clinic physicians and scientists contributing more than 6,000 publications to the medical literature each year, it is not possible to assess the future impact of important discoveries today and compare them to the contributions from the past. Rather, this compilation is intended as a ready resource and springboard for further investigation. Supporting documents for each of the 150 entries, and all other contributions not included in this list, are preserved in the Mayo Clinic Historical Unit and Archive for subsequent research.

Dr. William J. Mayo said, “the glory of medicine is that it is constantly moving forward, that there is always more to learn.” This list should be a great source of pride for Mayo Clinic patients and staff, reflecting the many advances that are made possible by Mayo’s unique Model of Care. With appreciation for the colleagues who have gone before us, we look forward to a future of continued discovery and service at Mayo Clinic.



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Chair, Mayo Clinic Sesquicentennial Committee

150 Important Contributions to Medicine

- Developed and implemented the concept of integrated, multispecialty group practice of medicine. This is Mayo Clinic's most enduring and significant contribution to medicine.
- Developed a rapid way to diagnose surgical specimens (frozen section pathology), allowing Mayo Clinic surgeons to explore, diagnose and repair all in one operation
- Created an integrated medical record
- Isolated thyroxin, the principal hormone of the thyroid gland; only the second time a pure hormone had been isolated
- Developed a DNA test to rapidly diagnose anthrax
- Developed a system for grading cancer on a numerical basis, a system adopted worldwide and still used today
- Refined diagnosis of myasthenic syndrome as a disorder separate from myasthenia gravis
- Planned and constructed the first building in the world designed for a multispecialty integrated group practice of medicine
- Recommended preoperative treatment of exophthalmic goiter (Graves' Disease) with iodine, introducing a new era in thyroid treatment
- Described toxic multi-nodular goiter (Plummer's Disease)
- Developed the bail-out oxygen bottle, the A-14 oxygen mask, the Mayo-1 maneuver and other technologies to allow military pilots to fly higher and to avoid blackouts from excessive G forces generated during steep dives and other maneuvers
- First use of tar and ultraviolet light to successfully treat psoriasis
- Pioneered methods for measuring motility of the esophagus, leading to clinical methods now used worldwide
- Recognized giant cell arteritis (temporal arteritis) as a distinct clinical entity now well known for its potential serious complications in the elderly
- Isolated cortisone, a hormone from the adrenal gland, leading to the treatment of rheumatoid arthritis and other diseases with dramatic results. Two Mayo Clinic staff members – a research scientist and a clinician – shared the 1950 Nobel Prize in Physiology or Medicine for the discovery of cortisone.

- Introduced a new method of anesthesia, the administration of sodium pentothal intravenously
- Isolated a strain of H1N1 swine influenza virus in a human, advancing understanding of the animal-human link in epidemics, mutation and spread of emerging viruses
- Established the first hospital-based blood bank in the United States
- Developed the KWB classification, a prognostic classification of hypertension based on the retina, regarded as the basis for classification of accelerated hypertension
- Conducted the first therapeutic application of streptomycin to treat tuberculosis
- Established the first community-wide longitudinal study of child development in the world – the Rochester Child Health Project
- Developed the “ketogenic diet” for control of epilepsy
- Developed the histamine test for diagnosing pheochromocytoma
- Introduced in the cardiac catheterization laboratory many new technologies to measure arterial blood pressure and oxygen saturation
- Advanced studies of histamine in allergy leading to the development of antihistamines
- Developed and investigated sodium nitroprusside (Nipride), an intravenous drug that lowers blood pressure
- First recognized that transient ischemic attacks are precursors to cerebral infarction
- Performed the world’s first insertion of a plastic intracorneal lens
- Refined the Gibbon heart-lung bypass machine (thereafter known as the Mayo-Gibbon heart lung bypass machine) and performed the first series of successful open-heart surgeries
- Pioneered the concept of a dedicated postoperative intensive care unit for patients
- Initiated treatment with methyl tert-butyl ether to dissolve gallstones, providing an alternative to surgery
- Initiated use of prednisone as the accepted therapy to treat polyarteritis, previously considered untreatable
- Performed the first FDA-approved total hip arthroplasty in the United States, heralding the advent of joint replacement
- Demonstrated the link between insulin and diabetes, one of the first to use insulin in diabetes treatment

- Led formulation of national policy for the National High Blood Pressure Education Program, resulting in almost 60% reduction in strokes and 50% reduction in heart disease deaths
- Introduced the first computerized tomography (CT) scanner in North America
- Discovered and reported a link between the diet drugs fenfluramine and dexfenfluramine (fen-phen) and heart valve disease. The drugs were voluntarily withdrawn from the market.
- Published first description of acute organ rejection following transplantation
- Opened the earliest formal non-pyramidal program for postgraduate education of physicians
- Developed the magnetic resonance (MR) elastography test for diagnosing breast and liver pathology
- Developed a DNA-based test that can rapidly detect tiny amounts of the smallpox virus
- Developed a more accurate test for strep A, giving confirmed results within eight hours
- First treatment of asthma with cortisone
- Developed the transnasal approach to pituitary tumors
- Identified the predominant protein in eosinophil granules, the eosinophil Major Basic Protein (MBP)
- Discovered the lupus erythematosus cell (LE cell), leading to the first laboratory test specific for this systemic rheumatic disease
- Published first report of intraoperative electroencephalogram (EEG) recording in North America, advancing understanding of brain activity
- Defined histologic, serologic and molecular precursors of multiple myeloma
- Determined that among women with breast cancer treated with tamoxifen, the presence of two functional CYP2D6 alleles was associated with better clinical outcomes and the presence of nonfunctional or reduced-function alleles was associated with worse clinical outcomes
- Identified a gene critical to the development and spread of lung cancer
- Developed a new inhibitory mold agar for use in clinical laboratories as a growth medium for identifying disease-causing organisms in humans, improving the diagnosis of fungal diseases
- Introduced endosseous dental implants to the United States
- The first non-public health laboratory to offer routine, rapid and specific virology services based on the use of cell cultures

- Established the three-site Mayo Clinic transplantation program, the largest in the world
- Developed a rapid real-time PCR (polymerase chain reaction) assay that increased the amount of DNA available for analysis, revolutionizing the way diseases are diagnosed
- Pioneered biofilm-directed diagnosis of orthopedic implant-associated infection using a technique now used in laboratories around the world
- Described carpal tunnel release operation
- Developed a surgical approach for treating patients for what would be known as hypertrophic obstructive cardiomyopathy
- Refined and described extracranial-intracranial bypass surgery including the use of high flow saphenous vein external carotid/internal carotid bypass to both the anterior and posterior cerebral circulation
- Advocated earlier surgery in patients with aortic stenosis and reported the first 100 sequential aortic valve replacements with no mortality
- The Clagett procedure revolutionized the treatment of postpneumectomy empyema
- Reported a series of patients who underwent two-dimensional echocardiography-guided pericardiocentesis, a technique that markedly reduced the risk of such a procedure
- Redefined the initiating event in multiple sclerosis, demonstrating that the earliest pathologic event is injury to the oligodendrocyte rather than injury to myelin
- Demonstrated correlation between catheterization-derived and Doppler-derived data for pressure gradients across stenotic valves leading to a dramatic reduction in the number of patients with valvular heart disease undergoing cardiac catheterization
- Identified pyoderma gangrenosum, a painful ulcerating skin disorder
- Reported that Barrett's esophagus is a premalignant state
- Defined rare, destructive plaque-forming skin disorder known as necrobiotic xanthogranuloma
- Reported first intravenous pyelogram, an x-ray examination to study the kidneys and urinary tract
- Presented results of clinical trials on new treatment for basal carcinoma using the drug vismodegib
- Early adaptor, innovator and promoter of the transoral removal of laryngeal and oropharyngeal cancers

- Performed initial Cardiolite research, leading to worldwide use to rule out acute coronary syndrome in patients with chest pain
- Described a new tick-borne bacterium called Ehrlichia muris, responsible for diseases with flu-like symptoms such as fever, headache and muscle aches
- Performed the “bikini” cut, or transverse incision, which became the standard for cesarean delivery
- Contributed to awareness of “food as medicine” including fortification of flour with thiamin, and eradication/prevention of beri beri and Wernicke-Korsakoff syndrome
- Described the membrane defects of muscle fibers in Duchenne muscular dystrophy
- Reported that intravenous vitamin K corrects the hemorrhagic complications of bile duct obstruction
- Defined autoimmune hepatitis and demonstrated the benefit of prednisone as a treatment
- Demonstrated that police cars equipped with automated external defibrillators (AEDs) improve survival outcomes from cardiac arrest, leading to AEDs as standard issue in police cars
- Defined relationship between pancreatic enzyme secretion and malabsorption to establish rational basis for treatment of exocrine insufficiency
- Developed a multi-target DNA-based stool assay for detection of colorectal neoplasia and first demonstrated its clinical utility
- Pioneered clinical use of intrathecal morphine for cancer pain, a novel delivery method that became a mainstay of treatment for acute pain
- Developed MELD (Model for End Stage Liver Disease) to replace the Child-Pugh score used to prioritize the allocation of organs for liver transplantation within the United States
- Performed first successful resection of pheochromocytoma in North America
- Performed first extensive surgical sympathectomy
- Opened first vascular laboratory in the United States
- Emphasized the link between tobacco and Buerger’s disease, a rare disease of the arteries and veins in the arms and legs
- Described the molecular basis of immune recognition by T lymphocytes
- First use of an oral anti-coagulant in humans

- Published a group sequential approach for the interim analysis of clinical trial data that keeps the significance level at final analysis near the overall desired significance level. The “O’Brien-Fleming” stopping rule becomes a standard used in trials worldwide.
- Helped to create the widely accepted clinical practice guidelines for osteoporosis diagnosis and treatment
- Showed that there was no association between breast implants and connective-tissue diseases
- Described a method for measuring blood volume using injectable dye. This method became universally adopted and remains in general use today.
- Introduced the medical records-linkage system for people in Olmsted County known as the Rochester Epidemiology Project to study the occurrence and natural history of many diseases and generating more than 1000 publications
- Introduced the Ashby method for measuring red blood cell survival
- Described Factor VII as an important clotting factor
- Described the molecular basis of immune recognition by natural killer (NK) cells
- Developed minimally invasive MR-guided focused ultrasound as an alternative treatment to surgery for uterine fibroids
- Identified MTOR (mammalian target of rapamycin) as a key regulator of cell growth. This led to development of drug-containing stents to open blocked cardiac vessels.
- Conducted pioneering work in fluorescence in situ hybridization (FISH) for centromere, locus, telomere-specific probes
- Co-introduced a non-invasive porphyrin-based assay (HemoQuant) to quantify gastrointestinal blood loss
- First use of cortisone in treatment of inflammatory bowel disease
- Developed the treatment of lupus nephritis, a previously fatal disorder, with prednisone and azathioprine or cyclophosphamide
- Introduced many of the methods used today to measure ferrokinetics, iron absorption, blood volume and intestinal absorption of vitamin B12
- Described a new hormone class—phosphatonins
- Initiation of an ABO incompatible and positive cross-match kidney transplantation program

- First group practice in United States to offer electroencephalography as a routine clinical test
- Perfected nerve biopsy as a diagnostic tool for numerous disorders
- Developed clinical autonomic function tests that became the nation's standard
- Established global interest in early identification of mild cognitive impairment and its importance in treatment prior to Alzheimer's disease
- Established a world-leading Nicotine Dependence Center with emphasis on practice, research and education
- Developed the radial nursing station in the United States
- Established the National Diethylstilbestrol DES Registry, helping thousands of women manage cancer and obstetric risks from prenatal exposure to Diethylstilbestrol, a hormonal agent used to prevent miscarriage
- Described Hollenhorst plaques in the eye as a marker of cardiovascular disease
- Described the Kearns-Sayre syndrome, a mitochondrial cytopathy, one of the first descriptions of this rare neuromuscular disorder
- Invented the dynamic compression plate, used for internal fixation of bone after fracture
- Developed the first G-suit, a flight suit outfitted with air-filled bladders and a system of valves to protect pilots during high-speed maneuvers by increasing blood flow to the brain
- Described the definitive operation for removing thyroglossal duct cysts, the "Sistrunk" procedure
- Established feasibility of protein identification from formalin-fixed paraffin-embedded tissue sections
- Established an important test for accurate diagnosis of amyloid disease and previously uncharacterized amyloid-causing proteins
- Described use of extended field radiation therapy in treatment of Hodgkin's lymphoma
- Described the role of dendritic cells as key immunologic actors in antigen and onward presentation and processing in dermatomyositis, an inflammatory connective tissue of the muscle
- Performed treatment of rectal cancer with surgery (abdominal perineal resection)
- Described the anterior resection (sphincter-sparing surgery) for rectal cancer

- Invented numerous surgical instruments that are still in use today, including Mayo scissors, Mayo stand, Balfour abdominal retractor, Harrington retractor, Adson pick-ups, and Austin retractor, etc.
- Established the first operating room in the United States equipped with a dedicated electron beam accelerator to deliver intraoperative radiation therapy to treat solid tumors during surgery
- Performed the first heart-lung-liver transplant in the United States
- Established neoadjuvant therapy and liver transplantation for unresectable hilar cholangiocarcinoma
- Established the largest heart-liver transplant program in the United States
- Developed the Braasch cystoscope used in the field of endoscopic urology for over 60 years
- Perfected the technique for partial nephrectomy for management of malignant renal tumors
- Became the first multi-center designated comprehensive cancer center in the United States
- Performed first total pancreatectomy for islet cell disease
- Became the first clinic to obtain FDA approval for the C-11 Choline injection, a positron emission tomography (PET) imaging agent used to help detect recurrent prostate cancer
- Established a model to predict survival in patients with end-stage liver disease
- Invented the Boothby-Lovelace-Bulbulian (BLB) oxygen mask, revolutionizing high-altitude flight
- Demonstrated that stem cells can form new heart muscle cells, enabling the body to replace damaged heart muscle
- First published human studies in CT colonography
- Developed an effective surgical adjuvant therapy for high-risk rectal cancer
- Demonstrated that inherited individual variation in the thiopurine methyltransferase gene leads to differences in metabolism of 6-mercaptopurine that affect tolerability of this agent in childhood ALL. This study helped form the discipline of pharmacogenomics.
- First human testing of oncolytic measles virus strains in treatment of cancer
- Established many medical and surgical specialties
- Developed the first member of the B7 superfamily of molecules that govern immune regulation leading to novel targeted immune therapies in cancer

- Began one of the earliest nurse anesthesia programs
- One of the first centers to introduce BRAF testing as a screening tool to rule out the diagnosis of hereditary non-polypoid colorectal cancer
- Played a major role in introducing nerve conduction studies for clinical use
- Initial clinical use of peritoneal lavage to treat acute renal failure
- Utilized plasma exchange to improve severe attacks of multiple sclerosis and other related diseases
- Showed the role of senescent cells in the aging process such that a drug used to eliminate senescent cells allowed mice to stay active and healthy longer than their untreated counterparts
- Became a pioneering center for managing urinary tract calculi
- Developed and refined computer assisted stereotactic volumetric brain tumor resection of deep seated brain neoplasms



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