SANAMED
Online First: November 2025
ISSN-1452-662X

DOI: 10.5937/sanamed0-61606
Review article

THE LIFE AND LEGACY OF ERNEST AMORY CODMAN: A PIONEER OF OUTCOMES AND A FORERUNNER OF MODERN QUALITY MEASUREMENT SYSTEMS IN HEALTHCARE

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Primljen/Received: 20. 09. 2025. Prihvaćen/Accepted: 16. 11. 2025. Online First: November 2025.

Abstract: Ernest Amory Codman (1869–1940) was an American surgeon, reformer, and visionary whose work marked the beginnings of systematic quality measurement in medicine. The first part of this paper traces his life and career: his education at Harvard Medical School, his work at Massachusetts General Hospital, his conflicts with colleagues over his insistence on public reporting of outcomes, his founding of a private hospital, and the establishment of the Bone Sarcoma Registry—one of the first disease-specific registries in history.

The second part of the paper analyzes his philosophy of the "End Result System" through a comparative table in which its core principles—patient monitoring, complication tracking, transparency, continuous improvement, and accountability—are compared with their modern equivalents, such as outcome indicators, national registries, public reporting systems, quality improvement (QI) methodologies, and health information systems.

The paper concludes that Codman's work represents both the biographical story of a persistent reformer and a conceptual foundation for modern quality measurement systems in healthcare.

Keywords: quality of health care, quality improvement, evidence-based practice, hospitals.

Ernest Amory Codman and his idea of the "End Result System"

The National Academy of Medicine of the United States of America defines the quality of healthcare as the extent to which healthcare services increase the likelihood of good outcomes and reduce the likelihood of harm for patients (1). The World Health Organization also frequently cites this definition of quality in its documents (1).

In modern public health practice, quality implies not only technical efficiency and professional competence, but also the structure of the system, the processes that are applied, and the outcomes that are achieved. In this context, Ernest Amory Codman stands out as one of the first to systematically insist on measuring treatment outcomes, analyzing errors, and making them publicly available.

Ernest Amory Codman was born into a Puritan family on December 30, 1869, in Boston, Massachusetts, USA. He entered Harvard College in 1887, graduating with honors four years later. He then enrolled at Harvard Medical School, where he met and became friends with Harvey Cushing, the future eminent neurosurgeon (2). Codman graduated in medicine in 1895 and immediately began working in the Department of Surgery at Massachusetts General Hospital (MGH).

He was the author of the first English-language textbook on X-ray photography techniques. In Serbian medical literature, he is best known for the "Codman sign," seen in rapidly growing bone tumors and other aggressive bone lesions (3). On an X-ray, this sign appears as a triangular shadow between the bone cortex and the elevated periosteum.

Codman also made a significant contribution to shoulder surgery. In 1931, he described "chondroblastoma," a rare benign bone tumor later referred to as the "Codman tumor" (4). He also introduced **Codman's exercises**—a set of movements for passive mobilization of the shoulder joint (5). These exercises involve the patient standing with the torso bent forward, while the affected arm hangs freely and moves gently back and forth or in circular motions, like a pendulum, without activating the shoulder girdle muscles. They remain integral to many rehabilitation protocols, especially in the United States.

At the time of Codman's work, no organized system for monitoring healthcare quality existed. Physicians and hospitals were not required to record treatment outcomes, much less analyze or publicly disclose them. Codman recognized that such a lack of accountability deprived patients of clear information regarding the safety and effectiveness of their treatment, while depriving healthcare professionals of feedback necessary for improvement.

He believed that systematic outcome measurement would identify best practices and eliminate "the lazy and ill-trained surgeons of your community, even though they hold high places" (6). He openly criticized nepotism and the practice of promotion based on seniority rather than merit, arguing that such systems perpetuated poor medical practice and turned it into dogma.

Through his revolutionary concept of the **"End Result System,"** Codman proposed that "[E]very hospital should follow every patient it treats long enough to determine whether or not the treatment has been successful," and then ask, "If not, why not?" (6). In essence, this meant:

• every patient deserves to know the final result of their treatment,

• every doctor should be willing to present their results to the public, and

• hospitals should be evaluated by the success of their treatments.

In practice, Codman used **"End Result Cards,"** measuring 12.5 × 20 cm, on which physicians recorded symptoms, initial diagnosis, treatment plan, complications, final diagnosis, and overall outcome—success or failure. He followed patients for at least a year after intervention. Codman publicly presented data on his deceased patients—141 cases—during his 15 years at MGH.

Codman was an uncompromising advocate of quality measurement, critical both of others and of himself. He called quality his "monomania" (7). In one report, after a failed operation, he candidly wrote:

"*I made an error of skill of the most gross character and even failed to recognize that I had made it.*" (6)

Although Codman's ideas are now widely accepted, they were highly controversial in his day. Many physicians felt that tracking errors undermined the profession's reputation and violated patients' trust. As a result, Codman was isolated and forced to leave MGH. Codman resigned from his job at MGH in 1911 to open his own hospital. He and his staff were able to track the status of every patient by implementing the "End Result System" in his own hospital, with between ten and twelve beds, demonstrating a commitment to the principle of accountability. Between 1911 and 1916, Codman recorded data on 337 patients at his own hospital and 123 "errors" or deficiencies in treatment (8). Determined to spread the word, Codman printed the results of two years of follow-up at his hospital— a rate of one complication for every three patients— and sent them to hospitals across the United States. In return, he asked for their complication rates. No one responded.

In his hospital, he further elaborated on the causes of adverse outcomes, classifying them into categories: "C" for accidents or causes beyond the operator's control; "P" for causes related to the patient and the patient's disease or unavoidable consequences of the disease; and "E" for error or preventable accident (9). He focused further on E errors, which he believed could be due to a lack of technical knowledge, skill, or surgical judgment, or diagnostic acumen on the surgeon's part. Errors due to equipment deficiencies were listed as institutional errors. This classification and accounts of his cases were published by Codman in his revolutionary study *A Study in Hospital Efficiency*, a book small in scope but of revolutionary contribution (8).

The real shock came in 1915 at a meeting of the Suffolk County Surgical Society (6). After a few lectures, Codman, as the section president, stepped onto the podium and revealed a cartoon he had commissioned. At the centre of the cartoon was an ostrich with its head buried in sand, surrounded by dozens of golden eggs it had laid. It represented the local surgical patients who, without the outcome-monitoring system he advocated, had enriched the MGH in blissful ignorance. It was the height of Codman's frustration. The drawing also featured the MGH board of directors, asking if they would stop laying golden eggs if they published "the truth about their patients." Those present could not believe their eyes. Codman had been considered a weirdo before, but the establishment couldn't get over the sting of such a slap in the face. Codman was asked to resign as president of the group. Doctors reduced the number of patients sent to his hospital, resulting in a nearly 40% drop in revenue over the next year.

Excommunicated by his former colleagues, he turned to other activities. He led Boston's medical relief teams in establishing an emergency surgical hospital that treated thousands of injured people after a catastrophic explosion when two ships collided in Halifax Harbor, killing and seriously injuring thousands of residents of the Canadian city. The makeshift hospital used "End Result Cards" for each patient. With the United States' entry into World War I, Codman became the senior surgeon for the defence of Delaware Harbor, spending much of his time dealing with influenza epidemics in his jurisdiction. The "End Result Hospital"

had fallen into disrepair in his absence. After the war ended, he returned to his closed hospital "in debt, unable to borrow, and somewhat disillusioned with the possibility of changing the ways of human nature" (3). Finally, the hospital had closed by June 1919.

Codman was not reinstated at MGH 14 years after his departure. He spent the postwar years developing the first disease registry. In one of his hundred papers, Codman described a method for tracking patients with criteria for reporting and the necessary information (10). He began his bone sarcoma registry in 1920 with a gift of $1,000 from a patient's family. Codman later received a grant from the American College of Surgeons (ACS). His first collaborators in analysing the data were pathologist James Ewing and surgeon Joseph Bloodgood (11). Codman, however, was not as successful in promoting it among his colleagues (12). Over the next six years, he collected data on only seventeen cases of sarcoma from other members of the association, which at that time had 7,000 members. The monograph resulting from the analysis of cases in the registry is the first attempt to standardize and disseminate the classification and nomenclature of a particular disease and the first estimate of the incidence of malignant diseases.

Direct results arising from the work on the registry are: longer follow-up of treated patients and calculation of multi-year survival rates; standardization of certain services (analysis of pathological material, radiographic diagnostics, etc.); promotion of national clinical research on a larger population through joint work of experts from different parts of the country; and creation of modern orthopaedics by linking pathology, radiology, and surgery.

Codman devoted the rest of his life to writing his autobiography, *The Shoulder* (13). For decades, this book was the textbook of shoulder orthopaedics in the United States. He continued to publish his results publicly each year, to the chagrin of his fellow surgeons who "spent their lives in the practice of the art of medicine rather than in that of the science, and, being financially successful, are able to influence the trustees of hospitals against analysis of the results; (and) comparison of achievements would be, to them, as odious as a comparison of incomes" (14).

The Shoulder was a textbook of the highest order, but for Codman it was a farewell letter for what he considered his most significant contribution to medicine. He prophetically pointed out that new generations would see the significance of the "End Result" approach, which "Harvard would claim as a jewel in her crown" (7). He suffered the fate of Ignaz Semmelweis (15). He died in 1940 of melanoma, in extreme poverty. He was buried in an unmarked grave, begging his wife to spend her savings on something more useful (16).

Main components and elements of Codman's idea with examples of modern implementation

Codman is one of the founders of the ACS, where he was the first head of the Department for Standardization (17). The Hospital Accreditation Program was developed in 1918 by this department, which later led to the creation of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). It was only after Codman's death that the idea of "quality care" became popular. Only under public pressure did JCAHO accept the need to study clinical outcomes as part of measuring the quality of care in the 1980s (18).

Implementation was challenging, however. Physicians and hospitals were reluctant to document clinical outcomes, citing various problems, including medico-legal, technical, or a lack of time (19)—excuses that are still used today. Under increasing pressure, JCAHO compromised by offering an alternative method that measured "quality" through "structure" and "process" (9). When it became apparent that poor clinical outcomes still occurred even when adequate "structures" (the existence of trained personnel and modern medical devices) and appropriate "processes" (clinical protocols, properly maintained medical records, etc.) were in place, advocates of the quality of care movement continued to fight.

Resistance from doctors and hospitals was so strong that the U.S. Congress eventually had to intervene, creating the Agency for Health Care Policy and Research (AHCPR) in 1989, whose primary mission was to conduct outcomes research and disseminate the results. The Agency's classification of medical errors is very similar to Codman's original classification (20). The establishment of this Agency was a triumph for Codman at the national level.

The Joint Commission established the **Ernest A. Codman Award** for using outcome measures to improve the quality and safety of patient care (21). The ACS website contains an online tool for estimating the likelihood of an unfavourable outcome (such as complications or death) after surgery, using information that the patient provides to the health care provider about their previous health history (22). Today, MGH has the **Edward P. Lawrence Centre for Quality and Safety**, which has been working since 2008 to improve the culture of quality at MGH and among members of the Massachusetts General Practitioners Association (23). With donations from the ACS, JCAHO, MGH, the Association of Shoulder and Elbow Surgeons, and an individual donor, a bust with his image in bas-relief was erected in 2014 (3).

Donabedian's quality model (structure–process–outcome) also builds on Codman's ideas (7). Most countries now have patient safety programs that require hospitals to track and report medical errors. These programs include the work of special teams composed of hospital management, administrative, and medical staff—exactly the type of interdisciplinary collaboration Codman advocated. Codman's systematic collection of data on bone sarcoma initiated the creation of disease-specific registries, allowing for outcome tracking in specific conditions. Whether good or bad, reporting on actual health outcomes is now a common practice in most developed healthcare systems. Codman's vision of quality in healthcare consisted of several key elements later developed into modern equivalents. Some of those equivalents are summarized in Table 1.

Europe has lagged behind the USA in adopting the quality philosophy. The same applies to present-day Serbia, where monitoring the quality of health care officially began in 2004, when the Ministry of Health published a document titled *Instruction on Monitoring the Quality of Work in Healthcare Institutions* as part of the program *Monitoring the Quality of Work in Healthcare Institutions in the Republic of Serbia* (24). In this regard, the Agency for Accreditation of Healthcare Institutions of Serbia and the Accreditation Body of Serbia were established. Unfortunately, studies on the effectiveness of accreditation on final outcomes are scarce, and the results published so far are contradicto-

Table 1. *Key elements of Codman's philosophy and their modern equivalents in healthcare quality*

Element	**What does it mean in practical terms?**	**Modern equivalents/correlations**
Patient follow-up	Monitor the patient after treatment to see if there has been a complete recovery and healing without complications or disability.	Outcome measures: recurrence, functionality, quality of life, mortality; disease registries; satisfaction with healthcare; clinical follow-up in RCTs and cohort studies.
Failure/complication records	Codman recorded all cases where treatment did not achieve the desired result and tried to determine why.	Morbidity and complications rate as standards in surgical reports; conferences on morbidity & mortality; root-cause analysis; clinical audit.
Objectivity and transparency	He wanted the results to be available, to know the errors, and to compare surgeons and hospitals.	Informed patient consent; public reporting of outcomes; licensing;(hospital) accreditation system; transparent recruitment of staff; national registries; online platforms with hospital comparisons; various lists of "best" hospitals at the national or global level
Continuous improvement	After identifying errors or failures, analyse why and implement improvement measures.	Efficiency; functional differentiation of hospitals, quality improvement (QI); PDCA / PDSA cycles; lean, six sigma NSQIP; patient safety programs; treatment process indicators (e.g. time to intervention, average length of hospitalization); healthcare worker satisfaction; hospital action plans; evidence-based medicine; continuing medical education; anaesthesia information management system (AIMS); quality management (QM)
Accountability	Doctors and hospitals should be held accountable for treatment outcomes; their work should be evaluated and criticized when unsuccessful.	Regulatory agencies; health care contracting; peer review; quality-based payment systems;case-mix, diagnostically related groups

ry (25). After several decades, the chambers of healthcare professionals were renewed (24). The challenges present in Codman's time still exist in today's Serbia, a century after the publication of *A Study in Hospital Efficiency*.

CONCLUSION

Ernest Amory Codman is one of the most significant figures in the history of modern medicine, whose vision far exceeded his time. His books hold the same importance for modern medicine as the *Corpus Hippocraticum*. His *End Result System* concept was the first systematic attempt to introduce the measurement of treatment outcomes as the foundation for improving quality and accountability in health care and medicine.

Although his ideas initially met with strong resistance, today they represent the foundation on which hospital accreditation programs, national and international disease registries, public outcome reporting systems, and patient safety initiatives are based. His work remains a powerful reminder that transparency, outcome monitoring, and continuous quality improvement are essential for the progress of medicine.

Modern quality measurement systems in health care cannot be understood without insight into Codman's philosophy, making him a pioneer and a turning point in the development of health quality improvement.

Abbreviations

USA – United States of America

ACS – American College of Surgeons

JCAHO – Joint Commission on Accreditation of Healthcare Organizations (now *The Joint Commission*)

AHCPR – Agency for Health Care Policy and Research (now *AHRQ – Agency for Healthcare Research and Quality*)

RCT – Randomized Controlled Trial

QI – Quality Improvement

PDCA / PDSA – Plan–Do–Check–Act / Plan–Do–Study–Act

NSQIP – National Surgical Quality Improvement Program (ACS program)

AIMS – Anesthesia Information Management System

QM – Quality Management

Conflict of Interest: The author declares no conflicts of interest related to this article.

Note: Artificial intelligence was not used as a tool in this study.

Source of Funding: The author declares that he did not receive any funds or support for this study from public, private, or nonprofit funding organizations.

Sažetak

ŽIVOT I NASLEĐE ERNESTA AMORIJA KODMANA: PIONIRA ISHODA I PRETEČE MODERNIH SISTEMA MERENJA KVALITETA U SISTEMU ZDRAVSTVENE ZAŠTITE

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Ernest Amori Kodman (1869–1940) bio je američki hirurg, reformator i vizionar čiji je rad označio početak sistematskog merenja kvaliteta u medicini. Prvi deo rada prati njegov životni put: njegovo obrazovanje na Medicinskom fakultetu Harvard, njegov rad u Opštoj bolnici Masačusets, njegove sukobe sa kolegama zbog insistiranja na javnom izveštavanju o ishodima, osnivanje sopstvene bolnice i razvoj Registra sarkoma kostiju kao prvog registra specifične bolesti. Drugi deo rada analizira njegovu filozofiju „Sistema krajnjih rezultata" kroz uporednu tabelu u kojoj se osnovni principi (praćenje pacijenata, evidencija komplikacija, transparentnost, kontinuirano poboljšanje i odgovornost) upoređuju sa savremenim ekvivalentima, kao što su indikatori ishoda, nacionalni registri, sistemi javnog izveštavanja, metodologije poboljšanja kvaliteta i informacioni sistemi. U radu se zaključuje da je Kodmanovo delo i biografska priča o upornom reformatoru i analitička osnova za moderne sisteme kvaliteta u sistemu zdravstve zaštite.

Ključne reči: kvalitet zdravstvene zaštite, unapređenje kvaliteta, praksa zasnovana na dokazima, bolnice.

REFERENCE

1. Mosadeghrad AM. Healthcare service quality: towards a broad definition. Int J Health Care Qual Assur. 2013; 26(3): 203-19. doi:10.1108/09526861311311409

2. Brand RA. Ernest Amory Codman, MD, 1869-1940. Clin Orthop Relat Res. 2009; 467(11): 2763-5. doi:10.1007/s11999-009-1047-8.

3. Nakayama DK. Ernest Amory Codman and the End Result Idea in surgical quality. Am Surg. 2023; 89(11): 4237-40. doi:10.1177/00031348221148344.

4. Codman EA. The Classic: Epiphyseal chondromatous giant cell tumors of the upper end of the humerus. Surg Gynecol Obstet.1931;52:543. Clin Orthop Relat Res. 2006; 450: 12-6. doi: 10.1097/01.blo.0000229309.90265.df.

5. Cunningham G, Charbonnier C, Ladermann A, Chague S, Sonnabend DH. Shoulder motion analysis during Codman pendulum Eexercises. Arthrosc Sports Med Rehabil. 2020; 2(4): e333-e9. doi: 10.1016/j.asmr.2020.04.013.

6. The Codman Affair 2015 [updated 2015-09-15. Available from: https://protomag.com/policy/the-codman-affair/.

7. Donabedian A. The end results of health care: Ernest Codman's contribution to quality assessment and beyond. Milbank Q. 1989; 67(2): 233-56; discussion 57-67.

8. Codman EA. The classic: A study in hospital efficiency: as demonstrated by the case report of first five years of private hospital. Clin Orthop Relat Res. 2013; 471(6): 1778-83. doi: 10.1007/s11999-012-2751-3

9. Margo C. Ernest A. Codman and the idea of medical accountability. Hektoen International a Journal of Medical Humanities. 2024.

10. Codman EA. The classic: the registry of bone sarcomas as an example of the end-result idea in hospital organization. 1924. Clin Orthop Relat Res. 2009; 467(11): 2766-70. doi: 10.1007/s11999-009-1048-7

11. McCarthy EF. The registry of bone sarcoma. a history. Iowa Orthop J. 1995; 15:74-8.

12. Codman E. The registry of bone sarcoma and medical human nature. Boston Med Surg. 1922; 187 :208-11. doi: 10.1056/NEJM192208101870608.

13. Gainty C. The autobiographical Shoulder of Ernest Amory Codman: crafting medical meaning in the twentieth century. Bull Hist Med. 2016; 90(3): 394-423. doi: 10.1353/bhm.2016.0071.

14. DePalma AF. Foreword - Codman [2025-09-20]. Available from: https://shoulderdoc.co.uk/pages/foreword-codman.

15. Paul S, Salunkhe S, Sravanthi K, Mane SV. Pioneering hand hygiene: Ignaz Semmelweis and the fight against puerperal fever. Cureus. 2024; 16(10): e71689. doi: 10.7759/cureus.71689

16. Mallon B. Ernest Amory Codman: the end result of a life in medicine: Saunders; 2000.

17. Neuhauser D. Ernest Amory Codman, M.D., and end results of medical care. Int J Technol Assess Health Care. 1990; 6(2): 307-25. doi: 10.1017/s0266462300000842.

18. Patterson CH. Joint commission on accreditation of healthcare organizations. Infect Control Hosp Epidemiol. 1995; 16(1): 36-42. doi: 10.1086/647001.

19. Berwick DM. EA Codman and the rhetoric of battle: a commentary. The Milbank Quarterly. 1989; 67(2): 262-7. doi: 10.2307/3350141.

20. Gleason KM, McDaniel MR, Feinglass J, Baker DW, Lindquist L, Liss D, et al. Results of the medications at transitions and clinical handoffs (MATCH) study: an analysis of medication reconciliation errors and risk factors at hospital admission. J Gen Intern Med. 2010; 25(5): 441-7. doi: 10.1007/s11606-010-1256-6.

21. Noble J. The Codman competition: Rewarding excellence in performance measurement, 19 -20. Jt Comm J Qual Patient Saf. 2006; 32(11): 634-40. doi: 10.1016/s1553-7250(06)32082-x.

22. Goodwin AM, Kurapaty SS, Inglis JE, Divi SN, Patel AA, Hsu WK. A meta-analysis of the American college of surgeons risk calculator's predictive accuracy among different surgical sub-specialties. Surg Pract Sci. 2024; 16: 100238. doi: 10.1016/j.sipas.2024.100238.

23. Mort EA, Demehin AA, Marple KB, McCullough KY, Meyer GS. Setting quality and safety priorities in a target-rich environment: an academic medical center's challenge. Acad Med. 2013; 88(8): 1099-104. doi: 10.1097/ACM.0b013e31829a3ee8.

24. Roberta M, Radulović O, Ignjatović A, Stojanović M, Višnjić A. Quality of healthcare in the Republic of Serbia: The concept we still strive for. Glasnik javnog zdravlja. 2022; 96(1): 71-7. doi: 10.5937/serbjph2201071M.

25. Markovic Petrovic G, Vuković M, Jovic Vraneš A. The impact of accreditation on health care quality in hospitals. Vojnosanitetski pregled. 2018; 75(8): 803-8. doi: 10.2298/VSP160728390M.

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***How to cite this article**:* Medarevic A. The life and legacy of Ernest Amory Codman: a pioneer of outcomes and a forerunner of modern quality measurement systems in healthcare. Sanamed. Online First, November 2025. doi: 10.5937/sanamed0-61606.

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