How Medical Imaging Improves Cardiovascular Care

Imaging offers early diagnosis, better therapy, and less disability, according to studies from peer reviewed medical journals

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In cardiovascular health, getting blood to the heart or brain—or, for that matter, to any organ or tissue—is essential. Without blood, human tissue dies. That is one of the primary reasons why medical imaging is so critical to cardiovascular care. It lets physicians see and understand whether the cardiovascular system is working, whether blockages are restricting blood flow, and whether the organs and tissues that make up that system—from heart valves to artery walls—are doing their job. When imaging identifies problems, it also takes a central role in helping provide treatment, whether angioplasty to re-establish blood flow, clot-busting drugs to remove a blockage, or guiding treatment for an aortic aneurysm.

Most often, imaging plays a quiet, somewhat offstage role in all of this. When statistics are cited about the dramatic drop in morality from stroke and heart disease—deaths rates from stroke have dropped by 30 percent and from heart attack by 50 percent over the past 20 years—medical imaging gets relatively little attention. But as studies in peer-reviewed journals continue to show, much of the diagnosis and therapy that has led to these dramatic improvements comes about from the pivotal information and insight provided by medical imaging.

This NEMA Policy Brief will summarize a few of the studies from peer-reviewed medical journals that describe the role of medical imaging in cardiovascular care.

Early Diagnosis and Therapy Reduces Disability Costs

Stroke is one of the most costly diseases in the U.S., both in terms of lives lost and overall costs. Every year, 700,000 Americans suffer a stroke, and about 270,000 stroke victims die. The total annual direct and indirect costs of stroke in the U.S. is $57 billion, much of which comes from the reduced productivity and lost earnings due to death and disability. Medical imaging is helping reduce this economic toll by identifying stroke early and enabling therapies that lead to faster recovery and lower nursing home and rehabilitation costs.

Numerous imaging technologies, such as ultrasound and MRI, provide high-resolution images of arteries, the vascular system, and the brain to identify blockages or the thickening of the artery lining. In addition, CT scans, diffusion-weighted imaging, and PET scans aid physicians in assessing whether surgery to clear clogged arteries that supply blood to the brain is needed.[1]

When stroke hits, imaging tests provide rapid information about the nature and location of stroke, and the extent of brain injury, thereby allowing physicians to make judgments rapidly about which treatment approach is best.[2] If the stroke involves a blocked artery, physicians can prescribe clot-busting drugs. If the stroke was caused by a hemorrhage, imaging can guide delicate surgical procedures to close ruptured arteries. Imaging also enables the use of microcoil stents to correct brain

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[1] See "Cost Effectiveness of Carotid Endarterectomy Clinical Study," Nussbaum ES, Heros RC, Erickson DL, *Neurosurgery*, 38; 237-244; 1996. Also see, *The Value of Investment in Health Care: Better Care, Better Lives*, MedTap International, p. 34, 2004.

[2] "Evidence-Based Neuroimaging in Acute Ischemic Stroke," Vo DK, Lin W, Jin-Moo L, *Neuroimaging Clinics North America,* 13 (2003), 167-183.

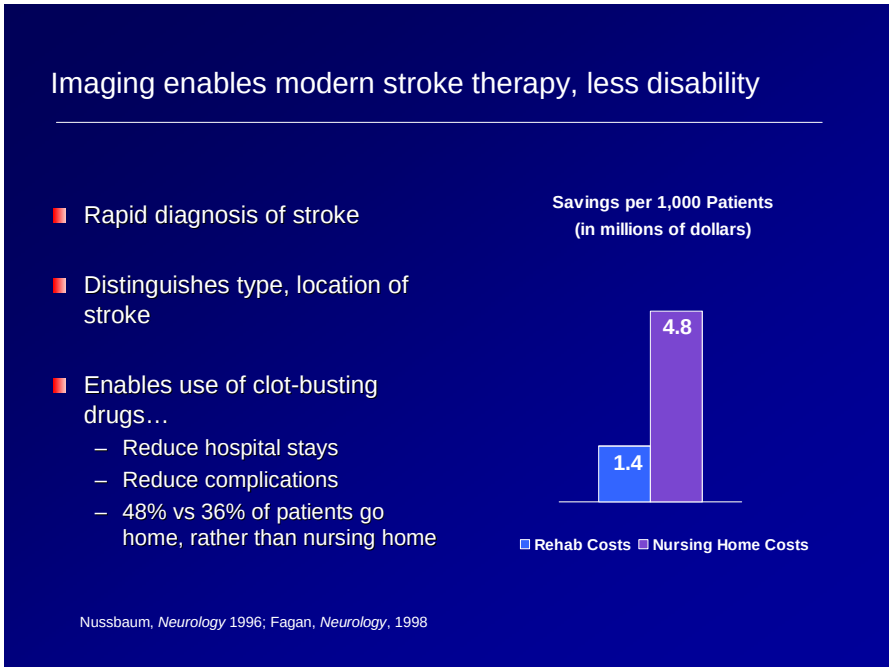

Figure 1: Clot-busting drugs that dramatically reduce long-term costs of disability from stroke can be administered only after physicians use medical imaging to identify the nature of the stroke. This study estimated that the net savings, after costs, of this therapy totaled some $4.5 million for 1,000 patients. Source: Fagan, *Neurology*, 1998.

aneurysms without open surgery, thus reducing patient hospital stays by half and allowing patients to recover in a month, rather than a year.[3]

The central role of imaging in stroke and cardiovascular conditions is well-documented in peer-reviewed articles, quality standards, and practice guidelines, including those of such groups as the American College of Radiology and the American College of Cardiology. All reflect the fact that, as one physician put it, imaging provides a "window on the brain."[4]

Information from CT and MRI critical in deciding about clot-busting drugs

Blockages in arteries and vessels in the brain—called ischemic brain attack—are the most common form of stroke, constituting some 80 percent of all strokes. If the blood supply is not restored quickly, disability and death are usually the result. Rapid imaging with CT, MRI, and other imaging technologies enables the use of clot-busting drugs known as thrombolytic therapy. This is the only approved drug treatment for ischemic brain attack and has been shown to save lives and reduce the overall costs of stroke. Without imaging, this therapy could not be used because its blood-thinning effects could endanger the lives of those patients whose stroke resulted not from clogged arteries, but from massive bleeding caused by a brain hemorrhage.

[3] "Surgical and Endovascular Treatment of Unruptured Cerebral Aneurysms at University Hospitals," by Johnston SC, Dudley RA, Gress DR, and Ono L , *Neurology*, 1999; 52:1799. Also see "Endovascular and Surgical Treatment of Unruptured Cerebral Aneurysms: Comparison of Risks," by Johnston SC, Wilson CB, Halbach W, Higashida RT, Dowd CF, McDermott MW, Applebury CB, Farley TL, Gress DR, *Annals of Neurology*, 2001, May; 49(5): 682-4. Also see, "International Subarachnoid Aneurysm Trial (ISAT) of Neurosurgical Clipping Versus Endovascular Coiling in 2143 Patients with Ruptured Intracranial Aneurysms: A Randomised Comparison of Effects on Survival, Dependency, Seizures, Rebleeding, Subgroups, and Aneurysm Occlusion," Molyneux AJ, Kerr RS, Yu LM, Clarke M, Sneade M, Yarnold JA, Sandercock P, *The Lancet*, Vol. 366, Issue 9488, September 3, 2005, Pages 809-817.

[4] "Imaging: Window on the Brain," Mazziotta JC, *Archives of Neurology,* Vol. 57, October, 2000, pp. 1413-1421.

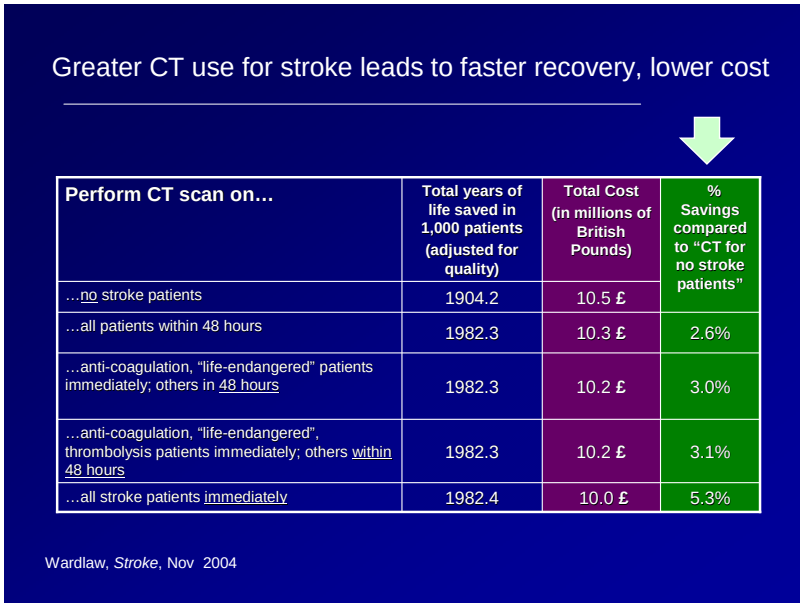

Figure 2: Scanning all stroke patients saves money because physicians are better able to diagnose the problem and develop treatment plans that reduce disability. Source: Wardlaw, *Stroke*, 2004

By enabling thrombolytic therapy, medical imaging also fosters significant savings. A study in the peer-reviewed medical journal *Neurology* (Figure 1) reported that the average length of hospital stays for patients who receive thrombolytic therapy is significantly shorter than for patients who do not (10.9 days versus 12.4 days).[5] Also, according to the study, some 48 percent of patients who received thrombolytic therapy (versus 36 percent of those who did not) went home from the hospital rather than to a nursing home.

For every 1,000 patients, according to the study, thrombolytic drug treatment creates an estimated overall savings to the health care system of $4.5 million. The savings arise from the fact that, although such therapy increases the costs of hospital care by $1.7 million, it decreases rehabilitation costs $1.4 million and nursing home costs $4.8 million.

Immediate CT Scans of Stroke Patients Reduces Costs

A 2004 study from the American Heart Association journal *Stroke* further underscores the critical role of imaging in improving stroke care—and saving costs associated with stroke.[6] The study evaluated the use of CT in helping diagnose the condition and guide physicians in how best to treat it.

The study involved 1,000 stroke patients from 70-74 years of age. It evaluated several strategies for scanning stroke patients with CT, as shown in Figure 2, ranging from use of CT in none of the patients (shown in first row) to performing CT scans on all stroke patients immediately upon their arrival at the hospital (on bottom row). Additional strategies reflecting variations in the timing of CT for specific types of patients and conditions are shown in the middle rows.

The purple column shows the total overall costs (in British pounds) in using CT for each strategy—thus demonstrating the savings in various approaches as compared to the "no scan"

[5] "Cost-Effectiveness of Tissue Plasminogen Activator for Acute Ischemic Stroke," Fagan, SC, et. al., NINDS rt-PA Stroke Study Group, *Neurology*, Vol 50, Issue 4 883-890.
[6] "Immediate Computed Tomography Scanning of Acute Stroke is Cost-Effective and Improves Quality of Life," Joanna M Wardlaw, et al, *Stroke*, November 2004, 2477-2483

strategy. The green column shows the percent of savings for each strategy as compared to the "no scanning" strategy. Note that the most intensive use of CT, which involves scanning all stroke patients immediately, saved the most in overall costs—that is, total cost of 10.5 million British pounds for the "no scan" strategy, and total cost of 10 million pounds for the "scan all" strategy. The reason for this is that CT scans dramatically improved the ability of physicians to treat patients effectively because CT provided vital information about the nature of the patient's condition.

With regard to the greatest improvement in quality—shown here in the blue column—you can see that the strategy of providing immediate scans for all stroke patients increased the quality adjusted life years by almost one year, compared to scanning no stroke patients.

In summary, this study shows that greater use of CT for diagnosing strokes leads to overall savings over alternative approaches and even greater savings than if CT were not used at all.

Imaging Identifies Blockages in Arteries to the Brain, Enables Surgery

Medical imaging also provides critical information about whether the arteries that supply blood to the brain are becoming clogged. This allows preventive care for patients, and it enables surgery—called carotid endarterectomy—that clears the blockages in patients with severe narrowing.

Peer-reviewed medical studies have shown that carotid endarterectomy is effective in preventing stroke in patients with severely clogged arteries. In fact, it extends lives more than a year—13.8 months compared to providing no therapy at all, and 11.2 months compared to aspirin alone.[7] In addition, a study in the journal *Neurosurgery* found that carotid endarterectomy saves anywhere from $3,000 to $5,700 per patient compared to the costs of taking no action. These figures reflect the cost savings in reduced long-term hospitalization, rehabilitation, and nursing home care for patients who ultimately experience a stroke.[8]

A variety of imaging technologies help physicians decide whether carotid endarterectomy is appropriate. These include CT scans of the brain, diffusion-weighted imaging, perfusion-weighted imaging, and PET scans. Imaging is also introducing new treatment options for opening clogged carotid arteries, including carotid artery angioplasty and carotid artery stents.

The Role of Medical Imaging In Heart Disease

One of the most dramatic contributions that imaging has made over the past 30 years has been its role in the significant improvements in mortality and morbidity of heart disease.[9] Advances in cardiac imaging have enhanced every aspect of cardiac care, including screening, diagnosis, treatment, and follow-up monitoring—providing detail unachievable even a decade ago.[10] Cardiac catheterization,

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[7] See "Cost Effectiveness of Carotid Endarterectomy Clinical Study," Nussbaum ES, Heros RC, Erickson DL, Neurosurgery, 38; 237-244; 1996.

[8] Ibid, Neurosurgery, 1996.

[9] See *The Value of Investment: Better Care, Better Lives*, by MedTAP International, February 2004. Also see "Trends in Heart Attack Treatment and Outcomes, 1975-1995, Literature Review and Synthesis," by Paul Heidenreich and Mark McClellan, in *Medical Care Output and Productivity,* edited by David M. Cutler and Ernst R. Berndt, University of Chicago Press, 2001.

[10] See Lewin Report, p. ii. Also see Alexanderson E, Granados N, Gomez-Martin D, Ricalde A, Meave A. [Evaluation of coronary artery disease by myocardial perfusion imaging in women] *Arch Cardiol Mex*. 2005 Jan-Mar;75(1):35-41. Also see Mowatt G, Brazzelli M, Murray A, Fraser C, Vale L. "Systematic Review of Single Photon Emission Computed Tomography (SPECT) Myocardial Perfusion Scintigraphy for the Diagnosis and Management of Angina and Myocardial

ultrasound, and CT scanning provide physicians with information about, and precise images of, blood flow, artery blockages, and heart functioning.[11] This information allows physicians to make earlier, more accurate diagnoses and to better target therapy. Also, medical imaging facilitates coronary angioplasty and, along with it, coronary stents to keep blocked arteries open.

Continued advances in imaging also provide new insights about cardiac activity. Multi-slice CT provides fast images of coronary artery calcifications, and CT angiography offers precise visualization of clogged arteries without use of invasive catheters.[12] In addition, MRI and nuclear imaging scans show functioning of the heart muscle at the cellular level. Non-invasive imaging is central to modern diagnosis and management of heart disease.[13]

Imaging Guides Angioplasty for Heart Disease

One of the best examples of the role of medical imaging in heart disease involves angioplasty, which is faster, easier, and much less expensive than bypass surgery. It is important to remember that angioplasty would not be possible without imaging. Using X-ray fluoroscopy that displays real-time images on large monitors, physicians are able to snake thin catheters to the exact location of a blockage and clear it.

According to a 2003 study in the *New England Journal of Medicine*, angioplasty is the therapy of choice for opening clogged articles. The study found that angioplasty reduced the chances of death, disabling stroke, or heart attack by a relative rate of 40 percent for patients at local community hospitals and 45 percent for those at invasive-treatment centers.[14] Most of the improvement was in the reduced rate of second heart attacks following the procedure. "The superiority of angioplasty over [drug therapy] was driven by a 75 percent reduction in the relative risk of clinical reinfarction [heart attack]…" said the study. An editorial in the same issue noted that "…primary percutaneous coronary intervention is now increasingly recognized as the reperfusion therapy of choice." [15]

Also in 2003, the British medical journal *The Lancet* reported that the combined results of 23 clinical trials, involving the random assignment of 7739 patients, found that patient outcomes for image-guided angioplasty were better than with drug therapy.[16] The study concluded, "The results seen with primary PTCA remained better than those seen with thrombolytic therapy during long-term follow-up, and were independent of both the type of thrombolytic agent used, and whether or not the patient was transferred for primary PTCA."

New York study shows dramatic savings from angioplasty

Infarction." *Nucl Med Commun*. 2005 Mar;26(3):217-29.

[11] See "American College of Radiology Clinical Statement on Noninvasive Cardiac Imaging," Weinreb, JC, et. al., *Radiology*, June 2005, Vol. 235, pp. 723-727.

[12]"Roles of Nuclear Cardiology, Cardiac Computed Tomography, and Cardiac Magnetic Resonance: Assessment of Patients with Suspected Coronary Artery Disease," Berman, DS, et. al., *Journal of Nuclear Medicine*, V 47, No 1, January 2006, pp. 74-82. Also see "How New Heart-Scanning Technology Could Save Your Life," by Christine Gorman and Alice Park, *Time*, Sept 5, 2005, pp. 58-71.

[13] "Roles of Nuclear Cardiology, Cardiac Computed Tomography, and Cardiac Magnetic Resonance: Assessment of Patients with Suspected Coronary Artery Disease," Berman, DS, et. al., *Journal of Nuclear Medicine*, V 47, No 1, January 2006, pp. 74-82

[14] "A Comparison of Coronary Angioplasty with Fibrinolytic Therapy in Acute Myocardial Infarction," by Andersen et al, in *The New England Journal of Medicine*, Vol 349, No 8; 733-742, 2003.

[15] "Primary Angioplasty for Acute Myocardial Infarction—Is It Worth The Wait?", by Jacobs AK, *The New England Journal of Medicine,* Vol 349, No 8; 798-799; 2003.

[16] "Primary Angioplasty Versus Intravenous Thrombolytic Therapy For Acute Myocardial Infarction: A Quantitative Review of 23 Randomized Trials," by Keeley EC; Boura JA; and Grines CL; in *The Lancet*, Vol 361, No 9351, Jan 4, 2003.

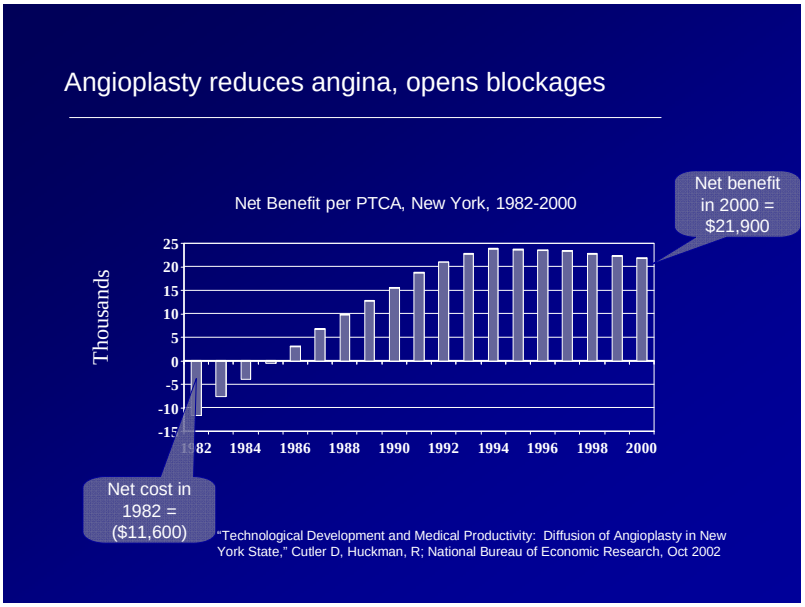

Figure 3: Study by Harvard economist David Cutler shows that the net benefit of imaging-guided angioplasty increased dramatically for patients in New York from 1980-2000. The net benefit was $21,900 per angioplasty during the year 2000. Source: Cutler, National Bureau of Economic Research, 2002.

Harvard economist David Cutler authored a 2002 study which was published by the National Bureau of Economic Research on the value of angioplasty in the State of New York from 1982-2000.[17] The study examined the costs and benefits of angioplasty—including the value of the reduced pain from angina. Cutler stressed in the report that reduced pain has a dollar value—in effect, that pain reduction is not just a luxury.

Figure 3 shows the cost versus benefit of each angioplasty. In 1982, the cost/benefit calculation worked out to be a net cost of $11,600 per angioplasty procedure. At this point, the technology was new. Physicians were still becoming accustomed to it. But as the technology grew more sophisticated and as physicians became more skilled in using it, angioplasty increasingly became a substitute for bypass surgery. Also, many patients who suffered from chest pain—but who may not have been sick enough for bypass surgery—received angioplasty to relieve their symptoms.

Thus, the chart in Figure 3 shows that the cost-benefit ratio begins to change in the late '80s and early 90's. When all of these savings are calculated—the savings from substituting for bypass surgery, as well as the economic value of reduced heart pain for these additional patients—the net economic benefit per PTCA procedure rose to $21,900 in year 2000. This number reflects the economic value of less pain from angioplasty, in addition to the lower costs of angioplasty versus bypass surgery. It is important to note that this calculation does not include the economic value of quicker return to work, fewer complications, or improved quality of life.

Therefore, as shown in Figure 3, during the 20-year period examined in the study, the utilization of angioplasty went up—but the economic value went up even faster. In fact, the economic value for patients just in the state of New York and just for the year 2000 was $750 million, according to the study.

[17] "Technological Development and Medical Productivity: Diffusion of Angioplasty in New York State," Cutler D, Huckman, R; National Bureau of Economic Research, Oct 2002