Cite this article as:
Mark McClellan and Daniel Kessler for the TECH Investigators
A Global Analysis Of Technological Change In Health Care:
The Case Of Heart Attacks
Health Affairs 18, no.3 (1999):250-255
doi: 10.1377/hlthaff.18.3.250

The online version of this article, along with updated information and services, is available at:
http://content.healthaffairs.org/content/18/3/250.citation

For Reprints, Links & Permissions : http://content.healthaffairs.org/1340_reprints.php

Email Alertings : http://content.healthaffairs.org/subscriptions/etoc.dtl
To Subscribe : https://fulfillment.healthaffairs.org

Not for commercial use or unauthorized distribution
A Global Analysis Of Technological Change In Health Care: The Case Of Heart Attacks

This preliminary report analyzes the spread of health technology in sixteen nations with widely divergent health care systems, using treatment of heart attacks as a case study.

by Mark McClellan and Daniel Kessler for the TECH Investigators

The technological Change in Health Care (TECH) Research Network is a new international collaboration of investigators in clinical medicine, economics, and epidemiology from sixteen countries. The network is providing evidence at the “micro” or disease level on differences in technological change across developed countries, and the causes and consequences of these differences. Building on prior research by most of the investigators, our initial comparative analysis focused on the treatment of heart attacks, although we expect that similar techniques can be applied to other conditions.

We are addressing three questions. First, how do national health policies affect technological change? Medical technology seems to be global: Clinical conferences and journals have worldwide audiences, and drug and device manufacturers have worldwide markets. Yet many studies have shown that economic and regulatory differences across countries can have a significant impact on how medical technologies are used at a point in time. But how do these economic and regulatory differences affect changes in medical treatment over time? For example, do countries such as Canada that use intensive procedures less frequently adopt medical practices like those in the United States with some delay, or are U.S. and Canadian practices diverging over time?

Second, what is the role of technological change in explaining medical spending growth worldwide? Analysts have speculated that technological change is the proximate cause of most of the rapid real growth in medical spending over the past half-century or longer, as new and improved medical treatments have become more widely used in the care of illnesses that previously were treated less intensively. Joseph Newhouse has argued that technology was the likely explanation for the fact that through the 1980s many Organization for Economic Cooperation and Development (OECD) countries with very different health care systems and levels of medical spending had apparently similar rates of spending growth. Exhibit 1, which updates Newhouse’s results through the 1990s, shows that recent medical spending growth has been more divergent, as many countries have implemented new policies to influence medical practices. Moreover, even modest differences in growth rates add up over time: Over the past quarter-century a difference in

Mark McClellan, a practicing internist, is assistant professor of economics and of medicine at Stanford University and a faculty research fellow at the National Bureau of Economic Research (NBER) in Stanford, California. Daniel Kessler is an associate professor at the Stanford Graduate School of Business and a faculty research fellow at NBER.
growth rates of just over 1 percent between the United States and Canada has accumulated to a difference in per capita spending growth of around 80 percent. Despite the global importance of health care spending growth, little is known about how differences in technological change contributed to these trends.

Third, what is the contribution of technological change to improvements in disease outcomes? Growing evidence suggests that population health is improving in most countries. If technological change differs across countries, then policies that affect technological change may have long-term, dynamic consequences for population health that are greater than simple point-in-time comparisons would suggest.

**Incentives For Technological Change**

Each participating research team reviewed the economic and regulatory incentives for technological change provided by their country’s health system, and any major changes in those incentives during the 1985–1995 period, according to a commonly accepted framework. Exhibit 2 summarizes some major incentive differences in our participating countries as of 1995. The left side of the exhibit shows incentives hypothesized to lead to stricter limits on the use of new treatments, particularly those that might be expected to increase costs. No simple table can capture all of the subtleties of each health care system; however, the fundamental differences described here are among those that investigators viewed as most likely to lead to significant differences in technological change. These and other incentives—including competition and choice among insurance plans, physician supply, and public information programs—are reviewed in more detail in our book.

**Major policy changes.** Many countries implemented important changes in policies over the past decade, providing opportunities for determining whether the policy changes affected technological change. For example, the Canadian province of Quebec and Sweden implemented expansions in the availability of cardiac procedures in the early 1990s. Other countries with similar incentives—for example, the United Kingdom, Denmark, and other Canadian provinces—did not. Before Taiwan enacted comprehensive national health insurance in 1995, approximately 45 percent of health care spending there came directly from consumers’ pockets; now the share is far lower. Israel adopted national health insurance in 1995, with a substantial change in provider payment incentives.

**Overall patterns of incentives.** Countries such as Canada and the United Kingdom provide very limited incentives for providers to adopt cost-increasing new technologies, by relying on global budgets and strong programs to regulate technology adoption (although Canada does pay its physicians on a
EXHIBIT 2
National Differences In Economic And Regulatory Incentives For Technological Change In Sixteen Countries, 1995

<table>
<thead>
<tr>
<th>Type of incentive</th>
<th>Strong limit</th>
<th>Intermediate limit</th>
<th>Weak limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs borne by patient</td>
<td>Substantial out-of-pocket payments: Japan, Korea, Singapore</td>
<td>Some out-of-pocket payments and/or significant optional private insurance sector with premiums borne directly by patients: Australia, France, Switzerland, United States</td>
<td>Zero/very low patient payments for services: Belgium, Canada, Denmark, Finland, Israel, Italy (for AMI patients), Sweden, Taiwan, United Kingdom</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Generosity of payments to hospitals(^a)</th>
<th>Fixed global budgets, more or less stringent: Canada,(^b) Denmark, Finland, Sweden, United Kingdom</th>
<th>Some additional payments for the provision of more costly treatments: Australia,(^d) Belgium, France,(^d) Israel, Italy, United States</th>
<th>FFS payments: Japan, Korea, Switzerland, Taiwan</th>
</tr>
</thead>
</table>

| Generosity of payments to physicians | Physicians mainly salaried: Denmark (cardiovascular doctors), Finland, France (public hospitals),\(^d\) Israel, Italy, Sweden, United Kingdom | Some additional payments for the provision of more costly treatments: Australia,\(^d\) Canada, France,\(^d\) Israel, United States | FFS payments: Japan, Korea, Switzerland, Taiwan |

| “Micro” technology regulation (mainly involves costly “high-tech” procedures and potentially expensive patients) | Extensive reviews of individual treatment decisions: United States | Limited case-level review and/or gatekeeping: Ontario, Canada (placement in bypass surgery queues), Denmark | Little or no case-level review: Most countries |

| Choice and competition among insurance plans | No choice (universal insurance): Canada, Denmark, Finland, Sweden, Taiwan, United Kingdom | Limited choice (for example, in supplemental coverage): Australia, France, Japan, Switzerland | Substantial choice: Korea, United States |

**SOURCE:** Summary classification based on predominant incentives in each health care system in 1995. See M. McClellan and D. Kessler, eds., A Global Analysis of Technological Change: Heart Attacks (Ann Arbor: University of Michigan Press, forthcoming), for a more comprehensive description of incentives for technological change in each country during the 1985-1995 period.

**NOTES:**

- **AMI** is acute myocardial infarction. FFS is fee-for-service.
- \(a\) Both level of payments and responsiveness of payments to changes in treatments may differ; this table focuses on responsiveness.
- \(b\) Canadian provinces have varied in the extent to which their governments have expanded funding and capacity for intensive treatments.
- \(c\) Some districts have implemented diagnosis-related group (DRG)-like payments that provide additional revenues for supplying additional treatment.
- \(d\) Australia and France have well-developed private hospital systems, with relatively generous incentives for technological change, operating alongside public hospital systems that have relatively strict incentives.
capped fee-for-service basis). At the opposite extreme, countries such as Japan, Korea, and Singapore provide considerable additional payments for new technology use, by relying on fee-for-service systems with little provider regulation. In between, many countries have systems that provide for some additional provider payments when more costly treatments are used. They might have a significant private insurance sector in which premiums and payments are not strictly regulated, or a provider payment system that absorbs some of the costs of more intensive treatments—for example, through payments based on diagnosis-related groups (DRGs).

International Differences In Technological Change

Our forthcoming book presents our initial comparisons of the association of these economic and regulatory incentives, and changes in incentives, with changes in care for heart attacks since the mid-1980s. Here we highlight a few results on the first question we raised: Do health policies affect technological change? We found modest differences of at most several years in the times at which most new treatments (procedures, drugs, or devices) became available in our participating countries. However, we found enormous differences in how quickly and widely treatments diffused into medical practice in each country.

High-tech changes. We define high-technology treatments as those with high fixed costs to adopt or high variable costs per use. For example, “invasive” heart attack treatments, including cardiac catheterization, angioplasty, and bypass surgery, require hospitals to incur substantial setup costs in hiring specialized personnel (for example, interventional cardiologists, cardiac surgeons, and specialized nurses) and purchasing specialized equipment (such as catheterization tables and fluoroscopes). We found very large effects of differences in incentives on trends in the use of high-tech procedures. For example, countries that use fixed provider payments experienced relatively little growth in use of invasive procedures over time. As a result, the use of high-tech cardiac treatments across countries has diverged substantially. These results suggest that limited regulation of the capacity for high-tech procedures and relatively “low-powered” incentives in countries that rely primarily on either fee-for-service or DRG payments—which provide significant additional reimbursement for performing the procedures—are important determinants of technological change in high-tech treatments. On the demand side, high out-of-pocket payments do not appear to slow high-tech change.

Intermediate-tech changes. Thrombolytic drugs are an “intermediate” technology in terms of resource use. The goal of thrombolytic use in heart attacks is to restore blood flow to the affected heart muscle before it dies. In the United States, where insurers generally have provided additional reimbursement for its use, tissue plasminogen activator (t-PA, a costly patented thrombolytic drug) has diffused widely. In contrast, except in critical blockages likely to be fatal, generic thrombolytics such as streptokinase or urokinase have become widely used in Canada and Sweden, where hospitals do not receive substantial additional reimbursement based on thrombolytic choice, and in Japan, where t-PA reimbursement rates are low. Overall thrombolytic use has increased more rapidly in these other countries compared with the United States, where catheterization laboratories are widely available and angioplasty (a high-tech substitute for thrombolysis) has become widespread.

Low-tech changes. We define low-tech treatments as those with low fixed and incremental costs of use. These are treatments that individual doctors or other health personnel
can provide with little additional input of labor, capital equipment, or materials. For example, clinical trials in the 1980s documented important survival benefits from the use of inexpensive drugs such as aspirin and beta-blockers soon after a heart attack. Although some countries do not collect reliable microdata on low-tech treatments, many have participated in the MONICA project—a World Health Organization (WHO)–sponsored longitudinal study of heart disease treatments and acute outcomes, which includes many of the investigators participating in the TECH project—and others have begun collecting such data in recent years. In these countries we have found less striking relationships between incentives and trends in treatment. For example, aspirin use has increased to very high levels in almost all of our countries over the past decade, and beta-blocker use also has increased substantially in most countries.

Changes in expertise or appropriateness. Although the international differences in rates of change in technology use are substantial, changes in treatment rates alone do not provide a complete guide to the quality or intensity of care provided. If medical professionals in a country have greater expertise or effort, they may target treatment use more effectively to patients who benefit most, leading to better outcomes than in another country with similar treatment rates but less effective targeting. We are investigating whether differences in the appropriateness of technological change exist across countries, and the reasons why. For example, does higher reimbursement lead to more effective treatment decisions for a given trend in treatment use?

Issues For Further Research

Our preliminary results on technological change worldwide suggest that “supply-side” incentives are very important for high-tech changes, and they also matter for other kinds of treatment changes. Which of the many rates of change experienced by our participating countries is “right” depends on the implications of the alternative rates of technological change for cost and outcome trends. Our book addresses these questions. For example, our results suggest that many countries have lower health care spending levels but similar rates of spending growth to the United States because prices are lower but rates of technological change are similar or more rapid. We also find modest differences in trends in heart attack mortality and other health outcomes, which may add up to notable differences in outcomes over long time periods.

Our preliminary results on technological change raise further questions. Do similar health care reforms in different countries have similar effects on technological change and its consequences? Are data adequate to conduct precise quantitative comparisons of the impact of technological change on changes in expenditures and outcomes across countries? Do differences at the micro level in trends in resource use and outcomes for particular illnesses match up with differences in aggregate trends in spending and health? As all developed countries continue to struggle with difficult questions about health care reform, explicit evidence on the relationship of health policies to changes in technology and their consequences for the productivity of health care systems is likely to become increasingly valuable for policymakers.

The authors thank Jean Agras and Kathy McDonald for coordinating the TECH research network and this report, and David Becker, Alan Garber, Jeffrey Geppert, Daniel Kao, Julie Lee, Joseph Newhouse, Olga Saynina, the editors, and an anonymous referee for helpful comments and technical assistance. They especially acknowledge all participants in the TECH network (listed below) for the research that is summarized here and the National Institute on Aging, the Stanford Graduate School of Business, the Stanford Institute for Economic Policy Research, and the Stanford Center for Health Policy for financial support.
NOTES
3. This paper summarizes some results from the first conference and book of the Technological Change in Health Care (TECH) Research Network. For a more detailed presentation of the initial TECH results, see M. McClellan and D. Kessler, eds., A Global Analysis of Technological Change in Health Care: Heart Attacks (Ann Arbor: University of Michigan Press, forthcoming). Participating investigators (and countries) include Brenden Bertuola, Diana Edwards, Elizabeth Geelhoed, Michael Hoffs, Richard Hockney, Jeff Richardson, and Iain Robertson (Australia); P.M. De Coster, Marie Closon, and Nathalie Maes (Belgium); Konrad Fassbender, David Hailey, L. Duncan Saunders, and Koon K. Teo (Alberta, Canada); Leslie Roos, Noralou Roos, Ruth Ann Soodeen, and Randy Walld (Manitoba, Canada); Peter Austin, C. David Naylor, and Jack V. Tu (Ontario, Canada); Mark Eisenberg, Vivian Ho Hamilton, Frederic Lavoie, and Louise Pilote (Quebec, Canada); Terkel Christiansen, Jørgen Clausen, Ivar Sonbø Kristiansen, and Jes Sogaard (Denmark); Kimmo Asikainen, Unto Häkkinen, and Ilmo Keskimaki (Finland); Brigitte Dormont, Isabelle Durand-Zaleski, and Stephan Jacobzone (France); Sylvie Goldman, Ziona Haklai, Jeremy D. Kark, and Amir Shmueli (Israel); Vincenzo Atella, Simona Giampaoli, Lorenza Pilotto, and Diego Vanuzzo (Italy); Saburo Ide, Akihiro Koike, Toru Maruyama, Tsuruhiko Nambu, Haruko Noguchi, Naoto Uemura, Akinori Urae, and Aki Yoshikawa (Japan); Bong-min Yang (Korea); Koon Hou Mak, Tze Pin Ng, and Kai Hong Phua (Singapore); Alexander Dozet, Sören Höglård, Anna Lindgren, Carl Hampus Lyttkens, and Hans Öhlin (Sweden); Alberto Holly and Fred Paccaud (Switzerland); Mei-shu Lai and Joan C. Lo (Taiwan); Rob Manning, Mark Petticrew, Nigel Rice, Mike Robinson, Mark Sculpher, and Trevor Sheldon (United Kingdom); and Jean Agran, Nathan Every, Alan Garber, Paul Heidenreich, Mark Hlatky, Daniel Kessler, Mark McClellan, Kathy M. Newhouse, and Olga Saynina (United States).
4. For example, see P. Danzon, Pharmaceutical Price Regulation National Policies versus Global Interests (Washington: American Enterprise Institute, 1997).
5. Much variation exists within these broad categories. For example, Canada pays its physicians on a capped fee-for-service basis, not salaried like many strict-incentive countries; some countries with strict overall budgets use little micro- or macrolevel technology regulation. Moreover, the average levels of provider payment for similar treatments also differ enormously, to some extent independently of the responsiveness of payment to more intensive treatment. For example, in Ontario the cardiologist payment for coronary angioplasty—an intensive procedures used to open a blocked blood vessel after a heart attack—was $267 (U.S.) in 1993. In Japan the payment for the same procedure was $1,300 (U.S.). Payments in Korea were much lower, and payments in the United States were much higher.
7. Cardiac catheterization is a procedure to image the blood flow to the coronary arteries (the vessels that supply the heart muscle). If a blockage is detected, a revascularization procedure to improve blood flow may be performed. The two main revascularization procedures used worldwide are angioplasty, which involves inflating a balloon at the tip of a catheter in the affected artery, and bypass surgery, which involves open-heart surgery to bypass the blockages.