

Impact of Technology

Overview

The healthcare academic literature seems to be saturated with articles on technology. The articles in this section are intended to be representative, covering a wide range of topics relating to the impact of technology on the healthcare system. Most articles assume that the overall impact is positive and focus on how to assess technology as it changes or what to do in light of its rapid and continuing advancement. Although these articles indicate overwhelming belief that technology's impact is one of potentially great benefit, different levels of caution accompany this positive assessment.

The greatest impacts of technology (beyond the obvious increase in medical ability and options) include the increasingly rapid pace of advancement (and consequently a significant amount of instability), increasingly intricate processes for weighing costs and benefits, more knowledgeable patients (which results in greater pressure to involve patients in decision making), and the burgeoning field of telemedicine. Information overload and loss of human touch are also often mentioned.

Defining Technology

Alexander works toward a definition of technology to evaluate its role in nursing care. Technology, from the management perspective, is seen as all the work and responsibility of providing a service. The rest of the articles appear to assume a medical science perspective, focussing more on the equipment and procedures used by those in the medical profession.

Measuring the Advancement of Technology

Alexander seeks to measure the changes in nursing technology over time. Sachdeva notes that different paradigms of distributive justice also contribute to this variance. Countries consequently vary on what technology is appropriate to adopt.

Green discusses, by comparison to evolution theory, the necessity (or inextricability) of many errors along with success in the trials that lead to technological advance. Due to this, methods such as New Product labels should be used to allow patient-consumers to make their own assessments about the value of new technology.

Describing New Technology

De Ville also provides an example by considering the ethical and legal implications of regular and widespread use of handheld medical computers. Positive or negative value judgment is withheld.

Damiano gives robotically assisted endoscopic coronary artery bypass grafting as an example of advancing technology that promises great benefit but first must undergo more trials.

Schlag considers the hopeful possibility of telemedicine for the future of surgery.

Assessing New Technologies

Kaushal provides an example by assessing, through a review of current literature, the value of information technology (IT) for reducing the amount of medication errors in pediatric healthcare, concluding that these technological interventions have a high potential for being of great benefit.

Another aspect of Sachdeva's article is an exhortation to carefully examine the impact of new technology to decide what is beneficial to keep and what should be discarded or delayed. Cutler also discusses cost vs. benefits. In reviewing five medical conditions, the benefits of health (measured by QALY) clearly outweigh the costs in four cases and benefits equal costs in one case (breast cancer).

Fuchs summarizes a survey of thirty medical innovations to discover their relative importance in the medical field from the patient perspective.

Randal writes that the continued use of screening mammography is political as much as scientific. Although research shows its efficacy to be questionable, most people want to denounce such results and favor the use of more mammograms.

Banta, similarly, uses the example of electronic fetal monitoring (EFM) to claim that people do not always assess technological advance carefully but automatically want to grasp what is most sophisticated, whether or not it is effective.

Farmer reports on the findings of a survey evaluating telehealth systems designed to link families of medically complex children to a variety of healthcare providers. Although challenges exist, the pursuit of this technology is likely to benefit pediatrics. Gray also reports the results of a trial – this one testing Baby CareLink, a telemedicine program designed to increase support and cut costs in caring for high-risk infants. According to the survey, improvement is already visible.

Impact of Industry on Health Technology

Hemminki warns of the challenges that industry presents to health technology assessment (HTA) groups. Legal action can slow the exchange of scientific information and drain economic resources. Therefore, research institutions must support each other to stop industry from curbing the efforts of HTA.

Gelijns expresses wariness of the blurring lines between industry and university. To maintain integrity and maximize benefit, these institutions must retain their distinct roles in the advancement of technology.

Impact of Economics on Health Technology

Meltzer discusses the substantial role that economics plays in healthcare technology decisionmaking. He provides basic principles of health economics to aid in wise

economic assessments. Foote also discusses the factor of economics, but urges that, despite the strain on costs, technology must keep pressing forward. (He discusses this in light of the benefits of medical advance with antidepressants.) Weisbrod discusses how insurers' coverage decisions on new technology affect investment in technology. Garber delineates the principles of evidence-based coverage, stating the main concern to be the adequacy of evidence. Due to the rapid change in technology, continual reassessment is needed to see if this main principle is satisfied. Danzon describes the symbiotic relationship between new technology and insurance coverage and its impact in pushing medical expenditure from the inpatient to outpatient setting.

Information Overload

Apuzzo considers the impact of the information overload caused by the Internet and urges neurosurgeons to continue to learn and critically evaluate information, as well as be prepared to help patients wade through their own exposure to information on the Internet. Cassileth considers the greater demands placed on oncologists due to this information overload. Spann applies this to family practitioners, believing that family practice is in peril unless family physicians can manage to keep up with current technology and information. Unfortunately, the biggest stymie is lack of finances.

Negative Aspects of Technological Advance

Only a handful of articles present the impact of technology in a negative light. As already mentioned, Banta sees the popularity of electronic fetal monitoring (EFM) as indicative of people's desire for technological advance, regardless of what is most beneficial.

Rivera excoriates the use of medical technology for futile clinical intervention – to sustain life in critically ill patients who have no reasonable hope of improvement. He questions who is responsible for this (usually the family) and what the motivation is (usually unreasonable expectation for improvement).

Kleinke asserts that a false hope that technological advance will cure the ills of the ailing U. S. healthcare system plagues the minds of many, even experts working within the system.

In Defense of Technology

In defense of technology, Barnard asserts that it is never technology, but only improper use of it, or technique, that is capable of causing inhumane treatment.

Alexander, J. W. and M. Kroposki (2001). "Using a Management Perspective to Define and Measure Changes in Nursing Technology." Journal of Advanced Nursing **35**(5): 776-783.

Keywords: Management, nursing, technology

Purpose: This paper aims to present a clear definition of nursing technology, which it then uses to measure change in nursing technology. From the management perspective, technology refers to all the work and responsibilities of those providing a service. This perspective is asserted as more beneficial than the medical science perspective, which sees technology as the equipment and procedures that facilitate nursing actions. Rather than the work of nurses being technology, it is the step that links technology to patients. The authors see this perspective as useless for nursing managers and researchers.

Data: The authors review and use data from several other papers. Several studies used factor analysis to determine the dimensions of technological change. They focus on one study that applied the management perspective to nursing units and uncovered three dimensions of nursing technology: instability, variability, and uncertainty. This demonstrated a way to measure the dimensions of nursing technology and identify change over time. A study of 34 nursing units in three hospitals from 1980 was compared to a study of 22 units in one hospital from 1990. Detailed measurements of the dimensions reveal that technology's impact does change over time.

Methods: This article uses the management perspective to define nursing technology and measure the changing dimensions of the concept. Alexander and Kroposki define nursing technology as "the nursing care processes used to change the status of an individual from a patient to a person no longer requiring nursing care" and discuss the defining attributes: raw materials, knowledge, and the process of changing raw materials into practical results. In the second half of the paper, they discuss the application of the concept of nursing technology to nursing units in order to detect changes in nursing technology.

Results: Alexander and Kroposki claim nursing managers need be aware of these changes to make managerial decisions that ultimately aim to improve patient results. The authors conclude that continual reassessment of technology is necessary for nursing managers to adjust to the changing technology.

Uses: The authors argue that nurse and patient satisfaction can be increased with attention to managing the impact of technology.

Limitations: The authors recognize that these definitions are not exact or common.

Apuzzo, M. L. J. and C. J. J. Hodge (2000). "The Metamorphosis of Communication, the Knowledge Revolution, and the Maintenance of a Contemporary Perspective during the 21st Century." Neurosurgery **46**(1): 7-15.

Keywords: Communication, information, Internet

Purpose: The authors discuss practical and philosophical elements of the escalation in scientific data availability and their impact on neurosurgery.

Data: No primary data is gathered.

Methods: The authors cover a breadth of issues related to communication methodology and overload and then discuss their viewpoint on how these issues affect the

field of neurosurgery.

Results: They believe that technological advances (which are animated most conspicuously with the Internet) combined with increased data have caused an information revolution that has, in turn, metamorphosed the nature of communication. The result is that "intellectual poverty spells disaster." Therefore, the authors argue that sound contemporary perspectives are increasingly essential. Neurosurgeons must keep abreast of the continual flood of new information. Some promises good: virtual conferences, on-line publishing, and virtual reality surgical training. Yet the concerns are of greater import, due to their potential danger. The computer interface separates doctor from patient, which risks severe detriments to the relationship. Also, as is well known, the Internet harbors much impeachable material. Apuzzo and Hodge conclude by enjoining neurosurgeons to continually be involved in the critical evaluation of information. Information overload must be combated by careful sifting, synthesis, and transmission of information.

Uses: This is especially helpful for informing the neurosurgical community of possibilities technology holds for the future of their field and for compelling them to critical and imaginative thinking.

Limitations: This paper is an opinion piece. Based on the same objects of research, other conclusions may be reached.

Banta, D. H. and S. B. Thacker (2001). "Historical Controversy in Health Technology Assessment: The Case of Electronic Fetal Monitoring." Obstetrical and Gynecological Survey **56**(11): 707-719.

Keywords: EFM, technology assessment

Purpose: The authors wrote an article in 1979 that questioned the efficacy of electronic fetal monitoring (EFM). In it, they reviewed 600 articles. Now they review the reception of the assessment by the medical community, patients, and media, and the subsequent status of EFM.

Data: Banta and Thacker provide the historical facts and figures of EFM over the past 50 years since its introduction.

Methods: This is a follow-up to a literature review. This paper's intended audience includes obstetricians, gynecologists, and family physicians, but it is of interest for obstetric patients as well. The history of EFM is outlined in detail: When introduced, EFM quickly diffused into common practice among obstetricians. Yet the evaluation of its efficacy was delayed, and so its usefulness was doubted. In 1979 Banta and Thacker assessed the efficacy of EFM and found it to have little benefit over auscultation and other accepted means of fetal heart monitoring. In fact, it seemed to increase the rate of Cesarean sections and it generated higher costs. However, their results were initially highly criticized and debate ensued for several years. Continued research has chipped away at the once stone-solid support of EFM. Today it is no longer recommended, but it is still routine practice, being used in up to 80% of labors in the U.S.

Results: The authors conclude that the controversy of EFM is a lesson to the medical community to assess the efficacy of new technology before adopting it as standard procedure.

Uses: This paper is useful for physicians as an example of technology's efficacy being

overestimated. For obstetric patients, it provides historical grounds for doubting the use of EFM.

Limitations: This is one side of the debate on the efficacy of EFM. Others would take the same historical facts and reach the conclusion the EFM is almost always the best choice for delivery.

Barnard, A. and M. Sandelowski (2001). "Technology and humane nursing care: (ir)reconcilable or invented difference?" Journal of Advanced Nursing **34**(3): 367-375.

Keywords: Nursing, technology, patient satisfaction

Purpose: This paper calls into question the presumed wall between humane nursing care and technology and considers whether this tension is genuinely due to such a wall. Barnard and Sandelowski set out to uproot entrenched views of the relationship between technology and human nursing care and reevaluate the relation in hopes of reaching a more veracious understanding.

Data: Recent scholarship on reproductive and imaging technologies and on emergency resuscitation are studied.

Methods: This is an opinion piece. These topics are examined in light of the current tension between nursing care and technology. As technological advance has allowed machine to increasingly resemble man, the line between man and machine has blurred. This is thought to be a root of less humane treatment of humans. Therefore, reactions to this pit technology as the bad against humane care as the good. This assumption is prevalent in much nursing literature, according to the authors. They give examples of its use in language...high touch v. high tech. The authors call this viewpoint into question.

Results: The authors conclude that it is not technology that is pitted against humane nursing care, but it is technique - how the technology is used in specific user contexts. Also confusing the issue are the meanings attributed to terms like "technology" and "human." Therefore, technology can be utilized for humanizing or dehumanizing purposes.

Uses: This article provides a beneficial launching point for assessing when the "evil" of technology is an invalid label and the source of harm lies elsewhere.

Limitations: This article does not provide conclusive evidence, although it does provoke needed thought on the role of technology in healthcare.

Cassileth, B. R. (2001). "Enhancing Doctor-Patient Communication." Journal of Clinical Oncology **19**(18s): 61s-63s.

Keywords: Alternative medicine, communication, Internet, oncology

Purpose: Cassileth seeks to inform physicians of the importance of communication with patients, an importance increasing due largely to the changes wrought by technology. Of special importance, these changes have increased the need for oncologists to be aware of complementary and alternative medicine (CAM).

Data: This is mostly an opinion piece using some secondary data.

Methods: Cassileth discusses three changes (beyond medical technology) that have altered clinical practice and the relationship between oncologist and patient. First, especially among cancer patients, a growing desire to increase the patient's role demands greater communication and care from the oncologist. A second

consideration is the increase of information available through computer technology and the Internet. This creates the potential for patients to be led into misunderstanding the legitimate information or accepting false claims or unproven methods. Thirdly, the information relevant to cancer care continues to increase, and the oncologist has an obligation to remain fairly knowledgeable in several relevant areas. Cassileth exposes these changes as detrimental, especially with the use of CAM products, if not accompanied by clear and helpful communication between the physician and patient. Faulty assumptions, absence of regulatory oversight, and product problems all contribute to ineffective and even harmful use of CAM by patients. Cassileth discusses several specific CAM products that have been found harmful when used concomitantly with chemotherapy or other cancer treatment.

Results: He concludes that it is of paramount importance that oncologist-patient communication include alerting patients to such products.

Uses: This is especially beneficial for specialists in understanding their role in the physician-patient relationship.

Limitations: It is not able to address the more prevalent issue of CAM use by those who do not consult physicians. This is also a concern for the medical community.

Cutler, D. M. and M. McClellan (2001). "Is Technological Change In Medicine Worth It?" Health Affairs.

Keywords: Medical benefit and cost, technology assessment

Purpose: This article seeks to address the benefits versus the costs of medical technology in light of the fact that most of the spending in health care is due to medical technology. This does not make the technological advances unwise as the benefits of health (measured by QALY) are said to outweigh the costs.

Data: The authors report on cost-benefit analysis of treatment of five conditions.

General rather than any specific treatment is considered. Primary and secondary benefits (lower lost income) are considered. Gross economic data are used.

Methods: Although only five conditions were analyzed, the authors apply their findings to all healthcare and state implications for public and private policy.

Results: In four of the studies (heart attacks, low-birthweight infants, depression, and cataracts), the benefits clearly outweighed the costs. In the fifth (breast cancer), benefits seemed to equal costs. The bulk of the article explicates these five conditions and how the conclusions were reached. Among these implications, they assert that overall the quality-adjusted price of medical care is falling and that, based on this, the research should factor in benefits as well as costs to provide more accurate data. The authors conclude that the benefits of medical spending are, overall, clearly worth the costs.

Uses: This article provides interesting analysis of the question of the benefit of medical spending against the costs.

Limitations: They admit that the findings are tentative due to the small breadth of sample conditions. No chronic diseases were investigated.

Damiano, R. J. J., W. J. Ehrman, et al. (2000). "Initial United States Clinical Trial of Robotically Assisted Endoscopic Coronary Artery Bypass Grafting." The Journal of Thoracic & Cardiovascular Surgery **119**(1): 77-82.

Keywords: CABG, robotic surgery, technology

Purpose: This paper summarizes a pilot study aimed to test the possibility of using robotically assisted microsurgical systems to create endoscopic coronary anastomoses. Coronary artery bypass grafting (CABG) through endoscopy has not been accomplished, due to the limited accessibility to the coronary arteries and the increase in surgeon's tremor caused by the use of endoscopic instruments. It is hoped that robotic systems will be able to overcome these difficulties and provide greater surgical dexterity.

Data: In this study the Zeus Robotic Surgical System, consisting of a surgeon interface, a computer controller, and two robotic arms, digitized and minimized the movements of the surgeon. Ten clinical patients underwent robotically assisted anastomosis of the left internal thoracic artery (LITA) to the left anterior descending coronary artery (LAD). (Zeus had previously performed successful surgery on cadavers and animals.)

Methods: The authors discuss the patient selection process, the setup of the robotic system in the operating room, and the statistics of the results.

Results: The surgeries' success lead the authors to conclude that robotically assisted endoscopic CABG is a feasible technique, and further tests are warranted to explore its potential.

Uses: This provides sound examples of data showing the latent benefits of robotically assisted surgery, which the authors hope will spur further discussion and experimentation.

Limitations: The amount of testing contained in the pilot study was too small to warrant bold claims about the future benefits of robotically assisted endoscopic CABG. No discussion of costs is presented.

Danzon, P. M. and M. V. Pauly (2001). "Insurance and New Technology: From Hospital To Drugstore." Health Affairs **20**(5).

Keywords: Insurance, outpatient care, technology, technological substitution

Purpose: This paper describes the relationship between insurance coverage and new technology (specifically, its impact in shifting medical expenditure from the inpatient to the outpatient arena).

Data: Statistics displaying the inpatient-outpatient shift in medical care spending are given. For example, between 1980 and 1998, the percentage of personal health expenditure due to hospital bills fell from 42% to 33%, while outpatient spending increased. Also, outpatient spending rose from 5% to 8%.

Methods: Through general economic reasoning, Danzon and Pauly apply this relationship of mutual causation to outpatient pharmaceuticals specifically. They discuss various empirical data that support this claim of mutual causation. They conclude with a brief evaluation of the changes, including inefficiency due to impediments like tax subsidy and coverage of ineffective treatment.

Results: The technology-driven shift from inpatient to outpatient settings is shown to have increased the scope of insurance coverage for outpatient treatments; conversely, increased coverage stimulated further technological advance.

Uses: The article supports traditional economic thinking on the insurance-technology relationship.

Limitations: The statistical data covered by the article is minor. Although the discussion is about technology, pharmaceuticals provide all the data and examples.

De Ville, K. A. (2000). "The Ethical and Legal Implications of Handheld Medical Computers." The Journal of Legal Medicine **22**: 447-466.

Keywords: PDA, technology

Purpose: In recent years, handheld computers, or personal digital assistants (PDAs), have enjoyed a precipitous wave of popularity among medical staffs and students. This article addresses several implications which the quick adoption of such powerful technology might have. It serves simply to highlight the possible implications of widespread use of PDAs. It does not endorse or support a specific scheme for PDA use.

Data: This is an opinion piece.

Methods: De Ville discusses generally the possible ethical and legal implications of each of the six main categories of medical software available for PDAs: (1) scheduling programs, (2) data management programs, (3) billing and charge-capture programs, (4) medical reference software, (5) medical prescribing, and (6) decision-support programs. Greatest discussion is devoted to this last category, which is the most dubious. If a machine begins making the decisions, will doctors forget how to "think like doctors"? He takes each category in turn and examines it in light of ethical and legal considerations. He discusses legal implications from the risk of too much early dependence to an eventual obligation to use them as they become standard practice.

Results: He concludes that further examination into the uses of handheld computers and their effects must be conducted before they become standard.

Uses: This is informative of the possibilities for handheld computers, both the benefits of their use and the cautions against too much reliance upon them. This pattern of technology adoption and legal implications may apply to other technology.

Limitations: The beneficial suggestions for thinking about medical PDA use is only applicable by doctors, not other healthcare professionals.

Farmer, J. E. and L. Muhlenbruck (2001). "Telehealth for Children with Special Health Care Needs: Promoting Comprehensive Systems of Care." Clinical Pediatrics **40**: 93-98.

Keywords: Community-based services, coordination, family services, Telehealth

Purpose: This article reports the finding of a 1997-1998 survey of healthcare providers utilizing telehealth programs to enhance service to children with special health needs

Data: Eleven healthcare providers in seven states utilizing telehealth programs are surveyed.

Methods: The questionnaires and conference calls focus on the uses of telehealth programs by health care providers. These include physical and behavioral health care, conducting developmental evaluations, addressing family/social concerns, and follow-up visits.

Results: The survey led the authors to draw four conclusions about the use of telehealth systems. (1) Telehealth systems can aid professionals in providing physical and behavioral healthcare, conducting developmental evaluations, and addressing

family and social concerns. (2) Telehealth is mostly used for follow-up visits and for child evaluation and recommendations to local health care providers. (3) Telehealth has the potential to develop in the areas of specialized services and community-based services for underserved children. (4) Several challenges to telehealth systems threaten their ability to be sustained, much less increase. (Especially salient is the need for sources of reimbursement.) Despite difficulties, this technology should be pursued, due to its efficiency in linking families to and coordinating with varied health care providers, which is critical for medically complex children.

Uses: This information demonstrates the benefits of pursuing telehealth programs.

Limitations: This article comments on the benefits of telehealth programs but does not provide data about the costs.

Footnote, S. M. and L. Etheredge (2000). "Health Tracking: Trends." Health Affairs **19**(4).

Keywords: Drugs, mental health, outpatient substitution, technology assessment

Purpose: This concise article considers the impact of biomedical technology and innovation on healthcare services and costs.

Data/Methods: This is an opinion piece with considerable secondary data.

Results: Outpatient and drug therapy will continue to be increasingly substituted for inpatient therapy. Due to new drugs and technologies increasing the demand for prescription drugs, new antidepressant prescription drugs provide a suitable case study. The authors outline how the improvement of technology has fueled the increase of antidepressant use by treating more conditions, fostering new applications, increasing product promotion, facilitating diffusion of drugs through primary care physicians, increasing insurance coverage, and receiving public support for growth continuance. A brief discussion of the growing concern over the discrepancy between the public demand for continued improvement in medical technology with the inability to finance such improvements follows. They conclude that, due to the immense benefits of biomedical technological advance, we must continue to move forward, evaluating new technologies and making them more effective.

Uses: This research abets researchers and policymakers in assessing and progressing with cost-effective drug use.

Limitations: The focus on antidepressants limits the scope of the analysis of outpatient prescription drugs and their inclusion under healthcare benefits.

Fuchs, V. R. and H. C. J. Sox (2001). "Physicians Views Of The Relative Importance Of Thirty Medical Innovations." Health Affairs **20**(5).

Keywords: Change, innovation, technology

Purpose: This article summarizes the results of a survey aimed at discovering the relative importance of thirty medical innovations to patients in hopes of drawing more general conclusions about the importance of medical innovation to patients.

Data: 225 leading internists provided their opinions on the thirty innovations.

Methods: Since patients are usually exposed to only a small branch of medical technology, the survey asked 225 doctors to give their opinions on the relative importance of medical innovations to their patients.

Results: Calculating mean and variability scores for each innovation, they discovered magnetic resonance imaging (MRI) and computed tomography (CT) scanning as the most important innovations. Overall, innovations in procedure were considered more important than innovations in medication, and innovations to treat cardiovascular disease were thought more important than those for other diseases. The greatest variance in innovation scores appeared to be proportional to the ages of the physicians.

Uses: This study is itself innovative in focusing on the importance of technology from the patients' perspective (although obtaining it through their doctors). This is helpful for any inquiries into that viewpoint.

Limitations: The survey was limited to 225 people and it could only extract opinions, rather than the medical facts of their personal practice. They acknowledge the difficulty of comparing treatments for different diseases.

Garber, A. M. (2001). "Evidence-Based Coverage Policy." Health Affairs **20**(5).

Keywords: Evidenced-based coverage, insurance, technology assessment

Purpose: Garber's goal is to outline several aspects of evidence-based coverage policies.

Data: Two evidence-based policy institutions - the Technology Evaluation Center of the Blue Cross Blue Shield Association and the Medicare Coverage Advisory Committee - are evaluated.

Methods: As comparative case studies, Garber delineates the use of evidence-based coverage policy in these two major programs. He then addresses the challenge that rapidly changing technology presents to evidence-based coverage policy.

Results: The main principle on which the system depends is the adequacy of the evidence. Full clinical trials are usually not required. Evidence must adequately show the benefit of a medical innovation, rather than accepting it unless compelling reasons show it to be more harmful than beneficial or it simply being the best guess. Required evidence evolves.

Uses: Insurers, in effect, allocate medical resources. This shows how their decisions can be made more effective. It also shows the impact of changing technology on the process. Effective care is more important than cost control in this process.

Limitations: The research and conclusions are limited by the fact of considering only two programs in which the principles of evidence-based coverage are attempted.

Gelijns, A. C. and S. O. Thier (2002). "Medical Innovation and Institutional Interdependence: Rethinking University-Industry Connections." The Journal of the American Medical Association **287**(1): 72-77.

Keywords: Technological development, university-industry relations

Purpose: Gelijns and Thier set out to question the relationship between university and industry in their relentless pursuit of scientific and medical advance.

Data/Methods: This is an opinion piece. Various veins of collaboration are discussed, such as overlapping roles, mutual gains, pharmaceuticals, medical devices, mechanisms of data transfer, and policy change. The authors consider each of the aspects above in light of the ethical boundaries and visions of each field.

Results: Typically the university-industry relationship is seen as one that benefits

everyone. However, the blurring line between the roles of the two institutions causes reason for wariness. The close ties and mutual benefit is especially apparent with medical technology development. Benefits include acceleration of knowledge generation, increased opportunity to learn, and the sharing of capacities and assets. But how extensive should collaboration be? The conclusion is that collaboration is beneficial, but must be constantly reevaluated to ensure that the mission of one realm does not overwhelm that of the other. The realms and roles of the university-industry relationship must be distinct, and doing so will work toward maximizing the benefits of collaboration.

Uses: The information is beneficial for both the university and industry realms to help recognize the role of the other and to remain faithful to the individual mission statements.

Limitations: This article is solely based on the perspectives of two people. Although it is well-informed, opinions on university-industry relations vary greatly. The authors recognize that government also plays a key role in this relationship that they have not explored in this article.

Gray, J. E., C. Safran, et al. (2000). "Baby CareLink: Using the Internet and Telemedicine to Improve Care for High-Risk Infants." *Pediatrics* **106**: 1318-1324.

Keywords: Home healthcare, Internet, telemedicine

Purpose: This paper shares the results of a trial that tested the usefulness of Baby CareLink, a telemedicine program aimed at reducing costs and increasing support for high-risk infants.

Data/Methods: A randomized trial of 176 very low birthweight infants was conducted to test family satisfaction with quality of care, physical environment, and visitation behavior as well as length of hospitalization using Baby CareLink. A control group received regular treatment and attention within the medical center.

Results: Baby CareLink uses videoconferencing and World Wide Web technologies to enhance the interactions between community providers, families, and staff. The CareLink reported overall higher satisfaction with quality of care and the potential for cost reduction.

Uses: The results support the authors' view that extending Baby CareLink will further improve the coordination and efficiency of care.

Limitations: This studied use during hospitalization. Further gains are possible posthospitalization. Families participating must have web access.

Green, S. A. (2001). "The Evolution of Medical Technology: Lessons From the Burgess Shale." *Clinical Orthopaedics and Related Research* **1**(385): 260-268.

Keywords: Human experiments, medical trials, product labels

Purpose: Green asserts that revolutions in healthcare - like that which is currently taking place in medical technology - harbor many new medical innovations, but only concurrently with many unsuccessful trials and models.

Data/Methods: This is an opinion piece.

Results: Green discusses the trial and error method of understanding evolution, as demonstrated in the Burgess Shale. Drawing a parallel, Green argues that this is also the way for medical technology to progress. Because many new medical

innovations are doomed to be unsuccessful, and we cannot discern which these will be, Green suggests that patient-consumers should be given mechanisms to weigh a new product's potential risk vs. benefit. He suggests, as an example, that all new drugs and devices temporarily be labeled New Product preceding FDA approval.

Uses: This demonstrates an important angle on cost-benefit analysis.

Limitations: Green's article has only one suggestion, regarding labeling of new products. This addresses only a small portion of possible errors in the trials of medical advance.

Hemminki, E., D. Hailey, et al. (1999). "The Courts-A Challenge to Health Technology Assessment." Science **285**(5425): 203-204.

Keywords: Legal barriers, technology assessment

Purpose: The authors hope to expose lawsuits against clinical research and practice that aim to impede the publishing of results that will damage industry. They want to widen awareness of this issue in hopes of retaining meaningful and objective health technology assessment. HTA provides evidence-based appraisals of technology that aid clinicians in optimizing their practice and inform policymakers and administration on issues such as coverage and regulations.

Data/Methods: These two case studies are used as examples to illustrate what may increasingly happen in the field of medical research.

Results: The authors discuss companies creating lawsuits against offices responsible for HTA in hopes of curbing printed results deleterious to their businesses. The lawsuits of the pharmaceutical company Bristol-Myers-Squibb Canada Inc. and Leiras, the producer of the contraceptive method Norplant, slowed and seriously threatened the publishing of sound research that found these companies' products were, respectively, only one of a class of useful drugs or harmful. Hemminki and Koivusalo believe that recent international treaties on trade and investment reveal that the position of industry to challenge HTA is strengthening. To prevent this, they suggest increased peer-review, institutional support for attacked researchers, and other methods to keep HTA from being curbed.

Uses: This information serves to warn those involved in health technology assessment so that more people will be thinking seriously about how to respond to these situations.

Limitations: This is an international paper but so is the problem.

Kaushal, R., K. N. Barker, et al. (2001). "How Can Information Technology Improve Patient Safety and Reduce Medication Errors in Children's Health Care?" Archives of Pediatrics & Adolescent Medicine **155**(9): 1002-1007.

Keywords: Information, medical errors, pediatrics, pharmacy

Purpose: This paper outlines the role information technology plays in reducing the number of medication errors in pediatric healthcare.

Data/Methods: The authors conducted a review of literature on current information technology error-reduction interventions. Secondary data is provided.

Results: Medication errors include errors in drug ordering, transcribing, dispensing, administering, and monitoring. These errors are considered adverse drug events

(ADEs) and are capable of injuring patients. Several interventions have a high potential for decreasing the number of errors. Among these are computerized physician order entry with decision support, robots, bar coding, intravenous devices, automated pharmacy systems, and computerized discharge prescriptions and instructions.

Uses: This information will hopefully serve as a means of reducing medication errors. This applies particularly to pediatrics, in which weight-based dosing is more critical.

Limitations: Many of the potentially beneficial interventions are in the earliest stages of development. It will be a long time before we will be able to know if they are truly beneficial. Costs are not discussed.

Kleinke, J. D. (2000). "Vaporware.com: The Failed Promise Of The Health Care Internet." Health Affairs **19**(6).

Keywords: Information, Internet

Purpose: That better healthcare Information Technology (IT) systems will result in a better healthcare system is a commonly held belief. Kleinke challenges this claim, asserting that the Internet and technological advance will not be the panacea for the ailments in the U.S. healthcare system.

Data/Methods: This is an opinion piece based on economic reasoning.

Results: Information technology, and particularly the Internet, are examined. Kleinke covers the recent history of information technology and the drive to fix the healthcare system by progressing even farther with technology. Although the Internet is superior to previous generations of IT, it - just like its technological predecessors - does not respond to the foundational problems of the healthcare system, which are rooted in economic, legal, regulatory, organizational, and cultural concerns. Kleinke concludes that, if anything, the craze over the deepening well of medical information provided by the Internet is serving to agitate the fundamental problems in the U.S. healthcare system.

Uses: This article provides useful arguments for anyone wanting to see general improvement in the healthcare system.

Limitations: This article is taciturn regarding suggestions for addressing the radical problems in the healthcare system.

Meltzer, M. I. (2001). "Introduction to Health Economics for Physicians." The Lancet **358** (9286): 993-998.

Keywords: Cost-benefit analysis, cost efficiency, health economics

Purpose: The large rise in healthcare expenditure in developed countries since the 1960's has resulted in economic assessments constituting a critical consideration in policy decisions on healthcare technologies. Meltzer writes this first paper in a Lancet series aimed at providing physicians with the basic principles of health economics that will increase the understanding of the relationship between those in medical practice, healthcare, and the economy.

Data/Methods: This is an introductory economics paper.

Results: Principles discussed include opportunity costs, identifying the appropriate perspective, correctly categorizing costs, discounting costs and non-monetary

benefits over time, efficacy, and effectiveness. Meltzer also discusses three methods of estimating costs and benefits: cost-benefit, cost-effectiveness, and cost-utility analyses.

Uses: Although primarily for physicians, this paper provides principles important for anyone interested in understanding the relationships between medical practice, the healthcare system, and national economics. It and its bibliography make a good reference.

Limitations: So many concepts are covered that almost all must be done briefly. Someone completely unfamiliar with these concepts and principles will struggle to digest so much new information.

Randal, J. (2000). "After 40 Years, Mammography Remains as Much Emotion as Science." Journal of the National Cancer Institute **92**: 1630-1632.

Keywords: Effectiveness, mammography, technology assessment

Purpose: Screening mammography has been through more randomized controlled trials than any other screening test, yet its efficacy is still held questionable. This short article traces the history of screening mammography's development and public opinion toward it.

Data: Secondary data from reports on trials testing the effectiveness of screening mammography are included in the article.

Methods: This is a historical review of research and controversy.

Results: The statistics of various trials are given which support the opinion that screening mammography in addition to clinical breast examination does not reduce breast cancer mortality. Early, disputed studies indicated no mortality benefit to women in their 40s getting regular mammograms but the latest studies showed no benefit to women in their 50s as well. Such results remain controversial and overall disliked. Randal predicts that screening mammography will remain common practice due to the politics as much as the science.

Uses: This article provides statistics that support the viewpoint that screening mammography is not as helpful as generally assumed. The four billion spent on mammograms in the US each year could be put to better use?

Limitations: The reasons for holding contrasting viewpoints are not discussed in the same depth, and so this article does not provide information from a neutral stance.

Rivera, S., D. Kim, et al. (2001). "Motivating Factors in Futile Clinical Interventions." Chest **119**(6): 1944-1947.

Keywords: Bioethical consultation, futile care, life support

Purpose: Due to modern medical technology, often life can be sustained in critically ill patients who have no reasonable hope of improvement. The authors set out on this research in hopes of finding who is responsible for these medical interventions, the nature of their motivation, and the role of bioethical consultation.

Data/Methods: One hundred cases of futile intervention were reviewed. Criteria for case selection included death during the current hospital stay and a bioethics consultation. Two doctors had to agree on the futility of the treatments. The

authors report their findings on who is usually responsible for sustaining the life, what the motivating factors are, and the role that bioethical consultation plays in such decision making.

Results: Regarding responsibility for providing terminally ill patients with futile treatment, the research shows the family to be responsible in 62% of cases, the physician in 37%, and a conservator in 1%. The greatest motivations included unreasonable expectation (58% of cases) and fear of legal consequences (14% of cases). The authors discuss "religious experience" as a factor that they had expected to have more impact than showed in their data. Bioethical consultations were effective in 59% of the cases. This leads the authors to believe that timely bioethical consultation can eliminate unnecessary patient suffering and medical costs.

Uses: This is a fruitful area for the discussion of ethical and medical principles, because it is an area in which standard principles are so often laid aside. The authors advocate bioethical consultation.

Limitations: The results are from one bioethics program at one hospital and the authors are participants in that program.

Sachdeva, R. C. (2001). "Measuring the impact of new technology: An outcomes-based approach." Critical Care Medicine **29**(8): N190-N195.

Keywords: Capital allocation, technology assessment

Purpose: This paper contends that the current medical era is one of limited resources and therefore pressure to evaluate new technology is increased. It is written for healthcare providers.

Data/Methods: This is an advocacy piece for new techniques for capital allocation. Some cases are described.

Results: Although new technology often requires large expenditure, careful selection of "appropriate" technology will tend to result in cost-efficient care and a long-run advantage. The main question is how to identify which technological innovations are "appropriate." To assess this, Sachdeva states four questions that must be addressed. (1) Should the organization invest in the new technology? (2) If so, what are the associated benefits and risks of the capital investment? (3) What is the impact on patient outcomes as a result of adopting the technology? (4) What is the return on investment to the organization? Sachdeva discusses techniques from the business and outcomes research areas that develop models to answer these questions and find the "appropriate" technology. The models facilitate integrating the business and clinical views as well as the institutional and societal views.

Uses: The models discussed in this paper can be used by healthcare organizations to identify when expenditure on new technology is worth the risk.

Limitations: This provides a brief introduction to many models.

Schlag, P. M., K. T. Moesta, et al. (1999). "Telemedicine: The New Must for Surgery." Archives of Surgery **134**(11): 1216-1221.

Keywords: Telemedicine, telesurgery

Purpose: The authors describe the future development of telesurgery.

Data/Methods: No data is presented in this advocacy piece. In this technical article, the

authors envision the possibility of telesurgery and the many problems that must be surmounted (including image standards, data interfaces and transport, image fusion, etc.).

Results: Imagined venues for digitization and virtual surgery are considered. Then simulations of telesurgery and teleconsulting in surgery are discussed. This article presents several pictures of virtual experiments working on these possibilities. One of the newest impacts of technology is in the field of telemedicine. Digital image communication is being used in teleradiology and telepathology. A hopeful future phase, according to the authors of this article, is the inception of telesurgery. The main missing prerequisite for breaking this ground is the digitizing of surgical data. All the potential benefits of telesurgery lead the authors to conclude that this technology should be pursued.

Uses: As this technology develops, the authors are hopeful that telecommunication applied to surgery will concentrate medical intelligence and ability at the location of the patients.

Limitations: The actual inception of this technology will long be in the beginning stages. Many unforeseen circumstances will most likely arise as the technology progresses.

Spann, S. J. (2001). "The Future of Family Medicine: Clinical Practice." The Journal of Family Practice **50**(7): 584-585.

Keywords: Family practice, Internet, specialists

Purpose: Spann writes a short article expressing concern over the growing desire in patients for specialists and the threat this poses to family medical practice.

Data/Methods: This is an opinion piece.

Results: Spann discusses the following: As technology continues to develop at a rapid pace, it sweeps patient-consumers along in its currents. People want immediate access to the best technology (implying specialists). This results in family physicians have an increasingly difficult time staying afloat. The changes that have come and are coming to healthcare this century put family practice in a position where it must redesign itself. The physician-patient relationship is still critical. But due to changes, such as the vast amount of medical information on the Internet, physicians have to meet the demands of more knowledgeable patients and stay updated with new technology that proves to be simpler or most cost-effective. The know-how and resources to update are available to family practitioners, but most are not in the financial position to do so. Spann concludes that what is needed to save family medical practice from the peril it is in is a new business model that makes redesigning affordable.

Uses: This encourages training of family practitioners and could inspire services to them.

Limitations: This is written mainly for family practitioners.

Weisbrod, B. A. and C. L. LaMay (1999). "Mixed Signals: Public Policy And The Future Of Health Care R&D." Health Affairs **18**(2): 112-125.

Keywords: Cost control, insurance coverage, technology investment

Purpose: This describes the problems faced by investors in medical technology due to

the uncertainty about what price will be paid for the technology.

Data/Methods: This is a combination of economic and public policy analysis.

Results: Most increase in medical cost has been due to technological development. The USA leads the world in development and in demand for development.

Uncertainty leads to higher requirements for investors' returns. Medical technology investment is uncertain due to the extensive developmental time, the efficacy/effectiveness uncertainty, laboratory/scientific uncertainty, and market uncertainty. The latter is the subject of this article. The decisions of insurers (including Medicare) as to whether and how much will be paid for new technology determines their profitability. Consumer demand, provider decisions, and politics play key roles. The coverage decisions made today about new drugs and procedures send signals to investors about the possible price for technology that will be introduced in the future. The signals are mixed, at best. The authors discuss the coverage of several examples and the implications. They discuss the concepts of cost-reducing and cost-increasing developments. The development of new technology takes place in an environment of cost control.

Uses: The authors hope to inform policy. They advocate ways to assure investors in effective medicine.

Limitations: The authors state that little is really known about how coverage decisions affect investment. They advocate research.