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The Weiland Medal: Clinical Research in Hand Surgery

Kevin C. Chung, MD, MS[1]

[1]Professor of Surgery, Section of Plastic Surgery, Assistant Dean for Faculty Affairs, The University of Michigan Medical School

Abstract

Clinical research designed to enhance the quality of healthcare has always received a great deal of national attention. Outcomes studies, clinical trials, and evidence-based research are key components of clinical research that have advanced the field of hand surgery. The purpose of the Weiland Award is to encourage innovations and progress in clinical research in hand surgery for the betterment of patients and to promote hand surgery's visibility in American medicine. This article will highlight my efforts in clinical research through three specific research themes: (1) outcomes research, (2) economic analysis, and (3) evidence-based research and quality assessment in healthcare.

Keywords

Weiland Medal; Clinical Research; Hand Surgery

Evidence-based medicine has moved to the forefront of healthcare discussions as patients, physicians, funding agencies, and health policymakers are demanding high quality research to enhance their understanding of healthcare decisions. Proponents of evidence-based medicine want physicians to either be armed with research information or have the ability to successfully search for the evidence. They want physicians to "be able to understand the patient's circumstances or predicament; to identify knowledge gaps, and frame questions to fill those gaps; to conduct an efficient literature search; to critically appraise the research evidence; and to apply that evidence to patient care (1)."

Even with these demands, appropriate clinical studies— from which evidence-based practice standards can be derived — are often in short supply. This is particularly true in surgical subspecialties. Because of the deficiency of evidence in surgery, there has been a recent revival in performing outcomes studies of surgical therapies, a process first proposed in the early 1900s by a pioneer in the field—Ernest Codman, M.D. Dr. Codman advocated for a critical evaluation of outcomes of surgical procedures by carefully documenting the end results of operations and frequently conducting quality assessment of patient care processes (2, 3).

Corresponding Author: Kevin C. Chung, MD, MS, Section of Plastic Surgery, University of Michigan Health System, 2130 Taubman Center, SPC 5340, 1500 E. Medical Center Drive, Ann Arbor, MI, 48109-5340, kecchung@umich.edu, Phone 734-936-5885, Fax 734-763-5354.

Despite the advocacy for a “revolution” in medical care, clinical research necessary for the development of evidence-based practice standards for many upper extremity conditions is still lacking. This was borne out in a review conducted by the Journal of Hand Surgery, which examined published studies in the field. At the time of this review, it was noted that of 3,107 articles, abstracts, and letters reviewed from 111 issues of the Journal, there were only 25 controlled clinical trials and 8 randomized controlled trials (4). Many of the studies published in the hand surgery literature were markedly underpowered because of a lack of formal sample size calculation prior to conducting projects (5). In our systematic review of outcomes research papers published in the Journal of Hand Surgery, 92% of them had level 1 impact based on the Agency for Healthcare Research and Quality criteria (6). A level 1 impact study confirms the effectiveness of existing treatment without changing physician or patient practices to enhance the overall quality of care (7). In a commentary to the readership of the Journal of Hand Surgery (8), I stressed the importance of enhancing the rigor of clinical research in hand surgery and encouraged the cultivation of more clinical scientists in this specialty. In a follow-up paper to examine the reasons for the declining number of clinical scientists in surgery, I have identified various causes for this decline, which include insufficient mentors and difficulty in obtaining funding for clinical research (9). In a sweeping change to overhaul the research infrastructure of the American Society for Surgery of the Hand (ASSH) under the leadership of Dr. Richard Gelberman, I lead the research task force to write the “white paper” to define the vision for research for the ASSH. This vision was put to action through the dedicated effort of Dr. James Chang, Director of Research, who in a short period of a few years, has fulfilled all the goals of the white paper to promote clinical research in hand surgery.

In order to develop evidence-based approaches for the treatment of hand surgery conditions, clinical scientists in hand surgery must first produce high quality clinical studies. The 14-year effort of my research program at the University of Michigan is to generate useful, high impact clinical studies to enhance clinical research for the hand surgery specialty. These projects can be categorized into three major study themes: (1) outcomes research, (2) economic analysis, and (3) evidence-based research and quality assessment in healthcare.

Outcomes research

Outcomes study is a form of clinical research that derives effectiveness data to guide patient treatment. In contrast to efficacy studies, which often represent the ideal conditions in randomized controlled clinical trials, effectiveness studies collect observational data from the community that mirror actual clinical practices. Outcomes assessment can take a variety of forms, including outcomes questionnaire design, large database analysis, economic assessment, and systematic review/meta-analysis.

One definition of outcomes research is “research on the management of patients that asks what treatment is effective and for whom in more realistic settings than ones used in randomized, controlled trials (10).” Rather than emphasizing the mere restoration of normal anatomy, the focus of outcomes research is on “the patient’s assessment of pain, function, quality of life, and satisfaction with the results of the intervention (10).” In 1983, The Socioeconomic Committee of the American Society for Surgery of the Hand recommended

the development of “a universally available system for measurement of outcome of disorders treatable by surgery… patient questionnaires and measurement checklists need to be developed and validated (11).” The central theme of my research program is to develop a universal outcomes tool for the hand, which culminated in the development of the Michigan Hand Outcomes Questionnaire (MHQ) after two years of intensive effort during my training as a Robert Wood Johnson Clinical Scholar at the University of Michigan. The MHQ has undergone careful reliability and validity testing and has shown to be a practical tool in over 100 field studies in the US and around the world. The MHQ is a responsive outcomes instrument for a variety of conditions related to the hand and provides uniformity in outcomes assessment in hand surgery (12).

Application of the MHQ for Rheumatoid Arthritis

One of the first major applications of the MHQ is in the field of rheumatoid arthritis (RA) hand surgery. Previous studies have shown that differences in physician opinion with regard to treatment often lead to wide variation in practice patterns (13). We conducted a study using the 1996 and 1997 Healthcare Cost and Utilization Project Nationwide (HCUP) Sample to evaluate large area variation associated with the surgical management of the rheumatoid hand (14). The HCUP database contains a 20% stratified sample from 19 states of over 6.5 million hospital discharges from more than 906 hospitals, including academic and private institutions. Data were obtained from patients with a diagnosis of RA who had undergone arthrodesis, arthroplasty, and/or tenosynovectomy procedures. We found significant variations in surgical rates across the 19 states for all three procedures ($p<0.0001$). Varying rates suggest that there are large variations in surgical practice patterns across states. Although many factors can contribute to variations—including patient preferences, access to care, and economic incentives—a large proportion of practice variation can be explained by the disagreement among physicians regarding appropriate therapy. The discrepancy between surgeons and rheumatologists on when to intervene surgically may also contribute to this large area variation. Because RA affects a large segment of the population, the variation found in this study indicates that major differences in treatment philosophy exist, which may hamper effective surgical treatment of this disease.

Based on the finding of large area variation in practice patterns, we conducted a national survey to evaluate physicians’ attitudes toward the effectiveness of common hand procedures performed for RA patients (15, 16). Five hundred hand surgeons and 500 rheumatologists were mailed questionnaires to complete for this study. We found that comparing hand surgeons to rheumatologists regarding the effectiveness of metacarpophalangeal (MCP) joint arthroplasty, 83% versus 34% believe it improves hand function ($p<0.0001$), 92% versus 59% believe it improves pain ($p<0.0001$), and 95% versus 67% believe it improves hand aesthetic appearance ($p<0.0001$). Only 19% of rheumatologists feel that sufficient quality information exists regarding the surgical options and outcomes of RA hand procedures. Rheumatologists and hand surgeons disagreed significantly on the appropriate timing of MCP joint arthroplasty ($p<0.001$) (Figure 1). This national survey confirmed our hypothesis that the large area variation found in our HCUP study is mainly related to differences in practice patterns between the two specialties, which greatly affect patient referral patterns. This variation may be caused by the lack of well-

designed prospective studies to determine the effectiveness of commonly performed surgical procedures for RA patients, including MCP joint arthroplasty.

This preliminary work resulted in a R01 grant funding from the National Institutes of Health (NIH) in which we have recruited over 150 RA patients with severe MCP joint deformity from the University of Michigan Health System, The Curtis National Hand Center in Baltimore, and the Pulvertaft Hand Center in Derby, England. Study patients elect whether they would like to enroll into the surgical group to undergo silicone metacarpophalangeal joint arthroplasty (SMPA) or the non-surgical group to be managed medically only by their rheumatologists. This cohort of subjects represents the largest experience to date in the world to evaluate outcomes of the SMPA procedure. This project has yielded the following papers (17–27) to comprehensively study various aspects of healthcare delivery and outcomes associated with SMPA. From these projects, we discovered that RA patients who underwent SMPA have large, significant improvements in patient-reported outcomes (using the MHQ) at 1-year after surgery (Figure 2) (17). Functional assessments using grip and pinch strength improved from preoperative values, but these improvements were not statistically significant. We also found that impaired function was the most important reason why patients chose to undergo SMPA, and pain relief was the second most important factor (19). In assessing patient preferences, we discovered a discrepancy between physician expectations and reality; when physicians were asked who they think values hand aesthetic appearance more, 73% chose women whereas 1% chose men (20). Furthermore, 43% of physicians felt that women were more likely to undergo RA hand surgery compared to 6% of men. In summary, our study found that women and men placed equal value on hand aesthetic appearance, function and pain, and were equally willing to undergo RA hand surgery. We also assessed RA patients' expectations of SMPA and how these expectations may influence their decision to undergo SMPA (21). Prior to deciding whether or not they would undergo SMPA, patients at our 3 sites who were eligible for the procedure completed a questionnaire on their expectations of what the surgery could do for them. Improved appearance and improved function were the two reasons equally cited by both surgical and non-surgical patients as being "very important" in undergoing SMPA. The non-surgical group was more likely to be most bothered by hand weakness (32 percent versus 0 percent, $p=0.01$), whereas the surgical group was more likely to be bothered by poor function (62 percent versus 23 percent, $p=0.02$). The non-surgical patients were more likely to value their own opinion as the most important factor in the surgical decision-making process, in contrast with the surgical patients who were more likely to view the opinion of medical experts as being most important. In summary, these studies assist us in understanding and addressing patient expectations and identifying which patients are most likely to benefit from surgery.

In terms of outcomes, we conducted an analysis on whether patients enrolled into our study with more severe MCP joint deformities (ulnar drift and subluxation) would have worse outcomes after SMPA (23). Rheumatologists often refer patients later in their disease, and surgeons frequently lament that RA patients are referred too little and too late. This analysis stratified a large cohort of SMPA patients into a severe cohort and a less severe cohort based on the amount of MCP joint deformity. The mean MCP joint ulnar drift and extensor lag of the four fingers prior to SMPA were summed and averaged. Patients were divided into two

groups: average deformity of <100° (less severe) or ≥100° (severe). Outcomes assessed were the MHQ, grip/pinch strength, MCP joint deviation angles, and Arthritis Impact Measurement Scales questionnaire (AIMS2). Interestingly, there was no difference in outcomes at the 1-year follow-up period between the two groups after controlling for age, gender, and baseline values. However, patients with more severe hand deformities did have worse ulnar drift and extensor lag after reconstruction. Despite the potential barriers to SMPA in RA patients with more severe hand deformities, surgical treatment is still beneficial. We also compared the outcomes of surgical versus non-surgical patients in our R01 study at the 1-year follow-up period (22). There was no difference between the two groups in terms of baseline variables (age, race, education, and income). At the 1-year follow-up period, the mean overall MHQ score showed significant improvement in the surgical group but no change in the non-surgical group, despite worse MHQ function at baseline in the surgical group. Ulnar deviation and extensor lag improved significantly in the surgical group, but the mean AIMS2 scores (a measure of overall health) and grip/pinch strength showed no significant improvement. The non-surgical group did not show deteriorating function during the 1-year follow-up interval, which provides evidence of the effectiveness of RA medications in curbing the destructive effect of RA in the short term. We are continuing to follow this important cohort of patients and will be able to determine if improvements in hand outcomes for SMPA patients are maintained or if either group shows worsening over time. Our results demonstrate that SMPA is a good treatment option, especially for patients with poor hand function and in whom medical therapy alone has not alleviated symptoms or slowed the progression of the disease.

RA is a disease that affects patients from all regions of the world, and we are interested in the care of rheumatoid patients from an international vantage point. We completed a qualitative analysis project of rheumatologists and hand surgeons in the US, the UK, France, China, Singapore, and Japan (18). These interviews were conducted one-on-one during my Bunnell traveling fellowship. This qualitative analysis revealed that there are large variations in the rates of rheumatoid hand surgery and care of rheumatoid patients throughout the world. Some of these variations were due to differences in economies, such as China, where rheumatoid hand surgery is considered a luxury because basic healthcare is more of a necessity. Other differences were due to culture, such as in Singapore, where surgery is generally avoided by the largely ethic Chinese population because care is provided by the extended family. The healthcare systems of these various countries also play a part in the care of rheumatoid patients. In the UK, discussions with rheumatologists revealed that tumor necrosis factor antagonists are expensive and thus their availability is limited. We further explored this phenomenon in an analysis of our R01 data comparing the baseline characteristics of patients in the US and UK (24). American patients have a significantly higher income level ($p<0.001$) and have completed higher levels of education ($p<0.001$) compared to the British patients. There were no significant differences between patients in the US and UK in terms of self-reported disease severity or deformity at the MCP joints. RA patients in the United States are more likely to take biologic medications ($p<0.001$), steroids ($p=0.02$), and Cox-2 inhibitors ($p=0.02$) compared to patients in the UK. These findings may be related to the healthcare systems in the two countries; compared to the UK, the US is less likely to ration visits, medications, and referrals to specialists. It

seems that more “potent” RA medications, such as biologics, are increasingly available and prescribed in the US. However, the perception of disease status and the medical care that is received by RA patients appears to be comparable in these two countries.

In the future, we plan to conduct an economic analysis of SMPA and evaluate the outcomes of various concomitant finger and wrist deformities in affecting outcomes. It has been hypothesized that the ulnar digits tend to have worse outcomes after SMPA than the radial digits (28), but these data were based on retrospective chart reviews with potential selection bias and imprecise measurements. It is also uncertain how swan-neck and boutonniere deformities affect SMPA outcomes. This unique prospective cohort of subjects will enable us to provide evidence to guide future treatment of RA hand diseases. Exciting future projects are being formulated with bioengineers to model hand postures and finger joint movements to assess the functional changes after SMPA and other hand reconstructive surgical procedures for rheumatic diseases. The use of precise sensors on the hand can present unique real-time functional data that were not possible in the past.

Application of the MHQ to distal radius fractures

Distal radius fractures (DRFs) are a public health concern. It is the second most common fracture in the elderly after hip fractures. Approximately 100,000 Medicare recipients sustain this injury each year (29). As the population of the US ages, more of the elderly will suffer from DRFs. In the US, about 10% of 65-year-old white women will sustain DRFs during their remaining lifetime, most commonly due to osteoporosis (30). The annual direct healthcare expenditure of osteoporotic forearm fractures in the US is $385 million (31).

Unfortunately, the optimal treatment strategy for DRFs in the elderly is unclear. Currently, there are four main types of treatment: close reduction and casting, percutaneous pinning, external fixation, and internal fixation. The more conservative techniques, which include close reduction and casting, percutaneous pinning, and external fixation, are less invasive and easier to perform, but may not adequately restore anatomic alignment. Osteoporotic bones in the elderly may be prone to collapse and displacement with these conservative fixation methods that are less rigid (32, 33). Furthermore, conservative techniques may have recovery periods as long as 6 to 9 months. With internal fixation, the elderly may return to normal activities sooner. The volar locking plating system (VLPS) has been shown to recover near normal function as early as 3 months after fixation (34). However, the internal fixation techniques are technically more challenging, and the invasiveness of the operation may be associated with higher complication rates. Despite these uncertainties in treating DRFs in the elderly, relatively few studies have been conducted to examine this issue. Currently available studies are based mainly on small case series derived from selected centers (33, 35–37). The costs associated with each of these treatments have not been studied.

The goal of the DRF research program that I initiated at the University of Michigan is to provide evidence for the most optimal treatment of DRF. This program has generated the following papers (34, 38–43). To establish the current available evidence on the treatment of DRFs, we conducted a meta-analysis of the outcomes of external fixation versus internal fixation for unstable DRFs (38). We screened over 4,000 articles on this topic and found 28

studies on external fixation and 18 studies on internal fixation that met our inclusion criteria. However, the majority of these studies were case series and there were only 5 randomized controlled trials, all for external fixation. This meta-analysis, which did not have data for the VLPS, did not detect clinically or statistically significant differences between external and internal fixation in pooled grip strength, wrist range of motion, radiographic parameters, pain, or physician-rated outcomes. Because of heterogeneity in the pooled data, clinical trials are needed to provide direct comparison amongst the treatment options for DRF. This first project established the following important criteria in designing future studies: (1) use validated, patient-rated outcomes instruments, (2) assess outcomes at multiple time points after surgery, (3) conduct multi-center randomized-controlled clinical trials, and (4) carry out economic analyses.

Because of the escalating interest in using the VLPS technology, we focused the next phase of research projects on understanding the outcomes of VLPS for treating DRFs. The attractive feature of the VLPS is the ability to rigidly stabilize cancellous, fragmented bones that are not amenable to screw fixation. Although this technology is widely used, outcomes data on the VLPS are still lacking. We began collecting prospective data on patients who had DRFs treated with the VLPS for the past several years to define a dataset that can be used to examine various outcomes associated with this new technology. We first tested the responsiveness of the MHQ and physical tests (grip, pinch, range of motion) for short (3 to 6 months) and long-term (6 to 12 months) outcomes of DRFs (39). Responsiveness is the ability to detect clinically meaningful change. We found that both the MHQ and physical tests are responsive and should be used in DRF outcome assessments. We also found that short-term outcomes were more responsive than long-term outcomes. In a subsequent 2-year prospective outcomes study of 161 consecutive patients treated with the VLPS, the effectiveness of the VLPS was established (34). The outcomes data were collected at 3, 6, and 12 months after surgery and included the MHQ, physical tests, and radiographic parameters. At 3 months, patients reached 80% of their functional outcomes. Patients continued to improve up to 6 months when they tended to reach a “plateau” and essentially remained the same when assessed at 1-year (Figure 3). This study lent evidence that the VLPS provides effective fixation of DRFs and is highly stable in maintaining radiographic reduction. We also determined that our protocol should be amended to assess patients even earlier because of the excellent recovery achieved at 3 months. Because there are little data regarding which factors may predict a better outcome after DRF treatment, we set out to provide answers to this question using the same large prospective dataset of patients treated with the VLPS (40). We found that a more severe fracture pattern did not predict a worse MHQ outcome; however, younger age and higher income were significant predictors of better long-term outcome. Precise anatomic reduction was found to enhance short-term functional outcomes. In order to further examine the effect of age, we compared the outcomes of older patients (>60 years) with younger patients (20–40) when treated with the VLPS (41). Patients were assessed at 6 weeks, 3, 6, and 12 months after VLPS placement. At 1-year, no significant differences were found between the older and younger age groups in MHQ scores, physical tests, or range of motion (Figure 4). Younger patients did tend to achieve a plateau in their recovery by 6 months, whereas it took 1-year for the older patients. Although previous studies have supported conservative treatment for elderly patients, our

study found that these patients can and should be treated as aggressively as younger patients to achieve similar outcomes. The use of the VLPS for elderly patients enhances recovery and quality of life over traditional methods by allowing them to use their hands earlier.

To further explore the epidemiology of DRFs in the elderly, we were awarded an R21 grant by the National Institutes of Health titled, “Understanding treatment variation of distal radius fractures in the US elderly.” The purpose of this grant is to use the largest database of elderly patients, Medicare, to explore variations in treatments over time, determinants of treatment choice, treatment outcomes, and costs of DRFs. Thus far, we have assessed changing trends in the treatment of DRFs in the Medicare population over a 10-year period (43). We evaluated the 5% sample Medicare data from 1996–1997 and 20% sample Medicare data from 1998–2005. We extracted information on four DRF treatment methods (closed treatment, percutaneous pinning, internal fixation and external fixation) and calculated frequencies and rates to compare the utilization of different treatments over time. Over the 10-year time period examined, the use of internal fixation for elderly DRFs increased 5-fold, from 3% in 1996 to 16% in 2005 (Figure 5). Closed treatment, however, remained the predominant method (1996: 82% to 2005: 70%). Patients over the age of 85 were significantly more likely to be treated with closed treatment ($p<0.0001$). There was large variation in the use of fixation methods by physician specialty; orthopedic surgeons were significantly more likely to use closed treatment than hand surgeons, whereas hand surgeons were significantly more likely to use internal fixation treatments. Since the introduction of the VLPS in 2000, there has been an increased application of internal fixation and a concurrent decrease in the rate of closed treatment.

Several ambitious multi-center clinical trial grant proposals have been submitted to the NIH for funding support. An R34 planning grant has been funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) to prepare a 18-center clinical trial to evaluate outcomes of DRF treatment for the elderly (Figure 6). We have form the WRIST (Wrist and Radius Injury Surgery Trial) study group to leverage this initial support by the NIH to submit a comprehensive R01 grant proposal to investigate the most optimal treatment options for the elderly.

Economic analysis

Economic analysis has become an important tool for determining which treatment strategy will provide the best outcomes for the cost. Consideration of cost and quality-adjusted life year (QALY) measurements are important for the national health policy agenda because they provide data to policy makers in evaluating treatments that enhance the lives of members of society. There have been relatively few economic analyses related to surgery, and in particular, hand surgery. In fact, we found that <1% of all outcomes studies published in The Journal of Hand Surgery (American and British volumes) from 1988–2004 were relevant to economic analysis (6).

An early effort of ours was a cost-effectiveness analysis to compare open versus endoscopic carpal tunnel release during the height of endoscopic carpal tunnel surgery controversy (44). Through an extensive modeling strategy based on the best available evidence, we found that

endoscopic carpal tunnel release was a more cost-effective procedure. However, a sensitivity analysis (incorporating the range of cost and utility in the calculations) revealed that the incremental cost-utility ratio was very sensitive to major complications, such as median nerve injury. Another important economic analysis project that we subsequently undertook was a cost-utility analysis to compare two treatments for scaphoid fractures—open reduction and internal fixation (ORIF) versus casting (45). Scaphoid fractures account for 70% of all carpal fractures, mostly occurring in young men of working age (46, 47). This common fracture results in substantial morbidity to working patients and imposes great cost to society. In this study, we obtained medical cost data using the Medicare Resource Based Relative Value Units, which represent a standardized cost structure from a federal program. In calculating the total cost, we also included indirect cost from loss wages due to time off from work. In order to acquire utility data, we created a time trade-off computer program. We used this computer program to ask medical students about various health states related to scaphoid fracture—were they willing to live less years in a perfect health state versus more years in a less desirable health state and if so, how much of their lifetime they were willing to "trade." This utility data were then converted to QALY measurements (effectiveness). We found that ORIF was the dominant treatment for scaphoid fractures, being less costly and more effective. Adopting ORIF as the standard treatment of acute nondisplaced mid-waist scaphoid fractures would potentially save $5911 per patient (Table 1). We have also conducted an economic analysis comparing total wrist fusion (TWF) versus total wrist arthroplasty (TWA) for the treatment of a poorly functioning rheumatoid wrist (48). TWF provides reliable pain relief and stability and is the most commonly applied management strategy, whereas TWA is a motion-preserving alternative that is gaining popularity. A time trade-off utility survey was developed to investigate patient and physician preferences for the potential outcomes of TWA and TWF. Using the societal perspective (calculating the costs experienced by society in general, rather than focusing on the costs experienced by the patient or the physician), we derived the costs based on the Medicare fee schedules for the surgical codes associated with TWA and TWF and their potential complications. Patients and physicians both showed a preference for operative management over non-operative management. Application of cost data indicated that the incremental cost per additional QALY gained for TWA over non-operative management was much lower than the $50,000/QALY deemed acceptable by society. TWA and TWF are both extremely cost-effective procedures, but TWA is associated with a greater expected gain in QALYs than TWF.

Departing from the economic analyses described above comparing two different treatment strategies, we evaluated the financial impact of treating emergency hand trauma patients at the University of Michigan Health System, an academic healthcare system (49). This study was undertaken because of the crisis in the US with the coverage of surgical emergency care (50), in particular, the shortage of willing hand surgeons to care for hand-injured patients (50–52). We examined billing records for 2,632 hand patients seen in the emergency department in 2005 at the University of Michigan Health System. We found that treating hand trauma patients is fiscally advantageous for the surgical department (professional margin of 25%) and marginally advantageous to the healthcare system (facility margin of 1%). Deficiencies in emergency department coverage are a result of declines in the numbers

of emergency departments, increases in emergency department visits, and decreases in physician supply. This study stresses the financial importance of hand surgeons and the need for adequate coverage by qualified hand surgeons.

As fiscal constraints are a reality in the nation, these economic analysis projects will be carefully scrutinized by payers to devote precious resources to treatments that are effective at an affordable price (53). We plan to conduct economic analyses on many of our current projects, including SMPA and DRF treatment. For SMPA, we will compare SMPA to the only other alternative—no surgery. Of course it is expected that the costs will be much greater with SMPA, however, the QALYs are also expected to be greater. A treatment that is more costly but more effective has to be weighed against its less costly but less effective alternative. Although there are no fixed values for cost-effectiveness thresholds in medicine, interventions that cost less than $20,000 per QALY are commonly adopted (54, 55). In regards to the DRF study, our Medicare data include costs related to DRF treatment within 12 months after the index treatment. Our hypothesis is that increased use of internal fixation procedures is associated with higher complication rates and increased cost compared to closed techniques but a lower need for later re-intervention.

Evidence-based research and quality assessment in healthcare

The outcomes movement began in response to the expansion of medical services in the 1950s and 1960s, which resulted in a demand by third-party payers for cost containment (56). Concerns were raised about the unknown end results or outcomes of these medical services, and whether the push to reduce cost would decrease the quality of healthcare. The movement toward a system to assess and account for medical outcomes was termed the “third revolution of medical care” by Arnold Relman (56), former editor for The New England Journal of Medicine. Evidence-based medicine, which may be considered the fourth revolution in American medicine, differs from the outcomes movement in that it emphasizes greater accountability, calls for evidence to justify all medical treatment, and may be tied intimately to physician reimbursement (57). Evidence-based medicine has been characterized as the movement to evaluate the safety, effectiveness, and cost of medical practices from the approach of best scientific evidence and to establish medical practice on such knowledge (58, 59).

The application of evidence-based medicine to the clinical setting has been broken down into a multi-step process of creating answerable questions, tracking down the best evidence to answer these questions, evaluating the evidence for its strength, summarizing the evidence, integrating and implementing the evidence into practice, and finally evaluating performance (60–62). In order to track down the best evidence, one of the most effective ways is to rely on systematic reviews. Systematic reviews are well-planned studies that address the shortcomings of traditional reviews by adhering to strict, reproducible methods and recommended guidelines (63). In our research, we have conducted systematic reviews/meta-analyses on SMPA (64), Kienbock’s disease (65), digital sympathectomy (66), risk of melanoma arising in large congenital melanocytic nevi (67), DRF treatments (38), arthroplasty versus arthrodesis for the rheumatoid wrist (68), post-traumatic joint reconstruction of the finger (69), and treatment of open tibial fractures (70). These reviews

collect all available evidence, evaluate the evidence for strengths and weaknesses, and summarize the evidence. For example, in our systematic review of arthroplasty versus arthrodesis for the rheumatoid wrist, we collected information on demographic data, surgical technique, pain, active arc of motion, complications, and patient satisfaction. We identified 18 total wrist arthroplasty studies representing approximately 500 procedures and 20 total wrist fusion studies representing over 800 procedures. Comparison of outcomes showed that total wrist fusion provides more reliable pain relief than total wrist arthroplasty. Complication and revision rates were higher for total wrist arthroplasty. Satisfaction was high in both groups. Postoperative motion was reviewed to evaluate whether arthroplasty provides a functional active arc of motion. Of 14 studies reporting appropriate data, three showed average active arc of motion within the functional range. In this systematic review, outcomes for total wrist fusion were comparable and possibly better than those for total wrist arthroplasty in rheumatoid patients. Because expensive interventions must demonstrate superior outcomes, wrist fusion may be the better treatment option. Although some feel that randomized controlled trials are needed for “evidence” in evidence-based medicine, in actuality, evidence-based medicine stresses finding the *best* available evidence (71). In this way, systematic reviews and meta-analyses can serve as excellent summaries of the available studies on a particular subject.

Integrating and implementing the evidence into practice is, of course, the job of the physician. Although some healthcare professionals, especially surgeons, have felt that evidence-based medicine curtails their autonomy and neglects patient individuality (59, 72–79), it actually urges the integration of the best evidence with clinical skill (73, 80). Thus, evidence-based medicine involves the combination of clinical expertise and professional wisdom with the best outside evidence to make important decisions about patient care (76, 81–84). After integration comes the evaluation of performance. These performance measures may exist in the form of outcomes studies or economic evaluations of surgical procedures related to rheumatoid arthritis and distal radius fractures. They are also relevant to assessing outcomes of thumb reconstruction using microvascular toe transfer (85, 86), open carpal tunnel release (87), four corner wrist arthrodesis (88), extra-articular distal radius malunions (89), treatment of thumb carpometacarpal osteoarthritis (90), and pyrolytic carbon arthroplasty (91).

Clinical research to improve the quality of patient care has been a consistent vision in my research program for the past 14 years. Efforts to measuring quality in surgical treatment and devising valid criteria to assess quality will be a persistent challenge in the next phase of my research endeavors (92). Ultimately, all projects undertaken must have a direct impact in improving patients’ lives. My opportunities to mentor a cadre of young investigators to pursue clinical research has been fruitful in producing trainees who have populated many medical centers in the US to address clinical questions relevant to hand surgery. It is an honor for me accept the Weiland Medal. I hope my research vision mirrors the hope and aspiration of Dr. Weiland and members of the American Society for Surgery of the Hand.

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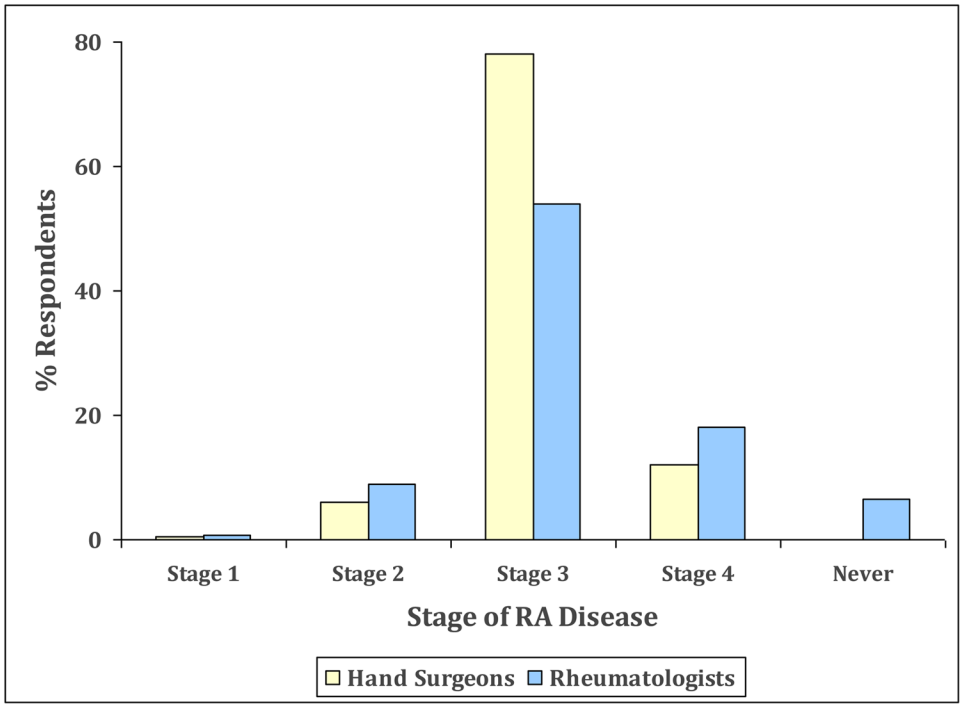

Figure 1.

Appropriate Time to Intervene with Metacarpophalangeal Joint Arthroplasty.

Source: Alderman AK, Ubel PA, Kim HM, Fox DA, Chung KC. Surgical management of the rheumatoid hand: consensus and controversy among rheumatologists and hand surgeons. *J Rheumatol* 30: 1464–1472, 2003.

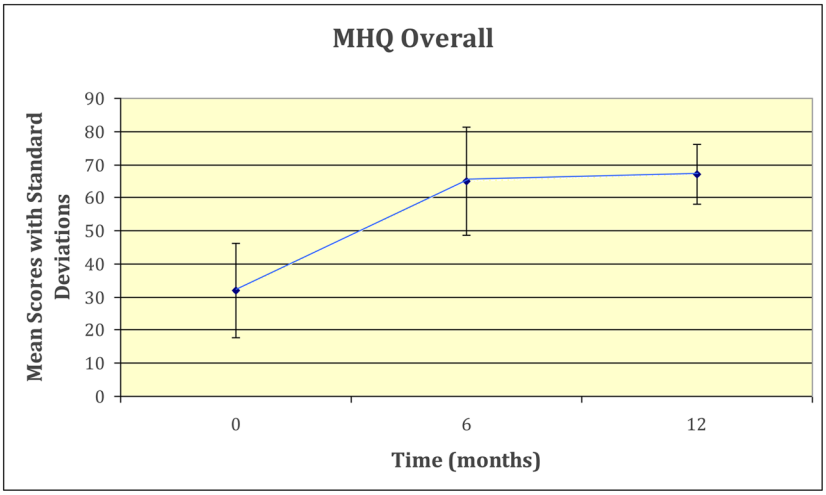

Figure 2.

MHQ Overall Mean Scores Improve substantially 6 Months after SMPA and are Maintained at the 1-Year Follow-Up Evaluation.

Source: Chung KC, Kotsis SV, Kim HM. A prospective outcomes study of Swanson metacarpophalangeal joint arthroplasty for the rheumatoid hand. *J Hand Surg* 29A: 646–653, 2004.

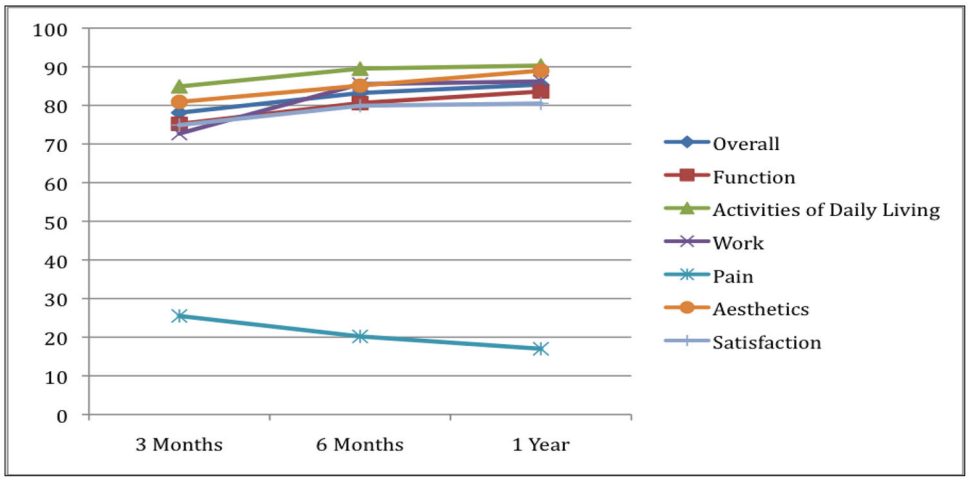

Figure 3.

MHQ Scores after VLPS Improve up to 6 Months and Reach a Plateau Thereafter.

*All of the MHQ scores are based on a scale of 0 to 100. For all of the scales except pain, the higher the score, the better the subject's hand performance. For the pain scale, the lower the score, the less pain that the subject experiences. The point on each line for each time period represents the mean score. Source: Chung KC, Watt AJ, Kotsis SV, et al. Treatment of unstable distal radial fractures with the volar locking plating system. *J Bone Joint Surg* 88A: 2687–2694, 2006.

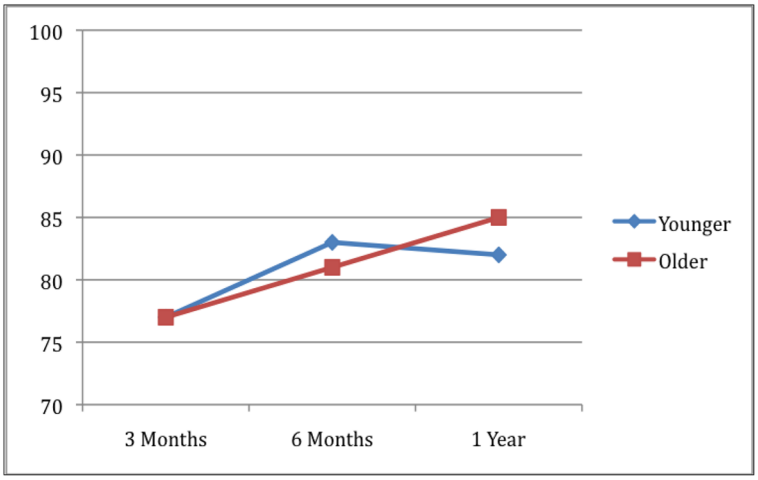

Figure 4.

Mean MHQ Score by Age Group after Volar Locking Plating System Treatment.

Source: Chung KC, Squitieri L, Kim HM. A comparative outcomes study of using the volar locking plating system for distal radius fractures in both young and adults over the age of 60. *J Hand Surg* 33A: 809–819, 2008.

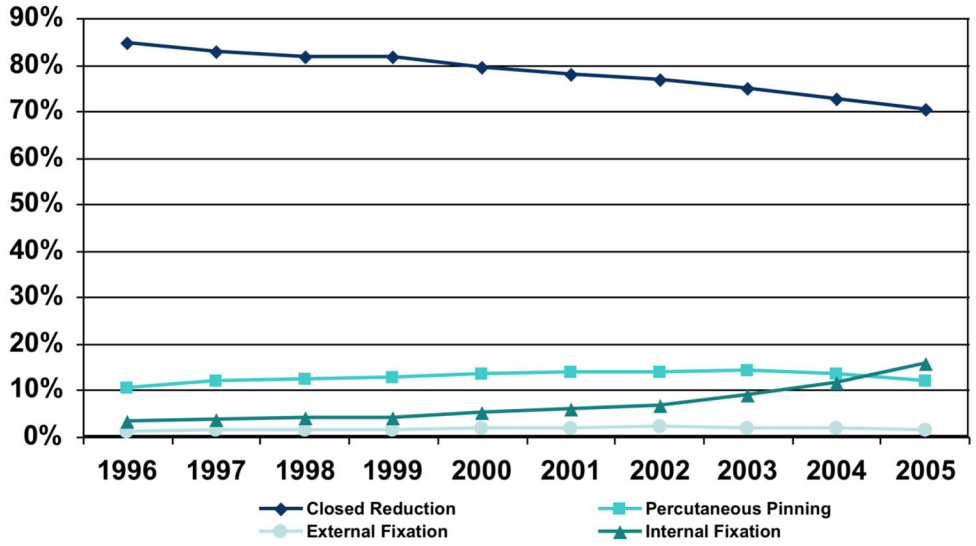

Figure 5.

Rate of Use by Fixation Method using the Medicare Database.

Source: Chung KC, Shauver MJ, Birkmeyer J. National trends in the treatment of distal radius fractures in the US elderly. *J Bone Joint Surg (A)*. 91:1868–1873, 2009.

Figure 6.

The WRIST (Wrist and Radius Injury Surgery Trial) Study Group

Bottom Row (From Left to Right): Tamara Rozental (Beth Israel Deaconess Medical Center), Joy MacDermid (University of Western Ontario), Jeff Friedrich (University of Washington), Steve Haase (University of Michigan), Doug Sammer (Washington University), David Dennison (Mayo Clinic), Thomas Hughes (Western Pennsylvania Allegheny Health System), Kevin Chung (University of Michigan), Warren Hammert (University of Rochester), Michael Hausman (Mount Sinai Medical Center), Andrew Koman (Wake Forest University), Philip Blazar (Brigham and Women's Hospital), Jennifer Moriatis Wolf (University of Colorado-Denver)

Top Row (From Left to Right): Jeff Yao (Stanford University), Myra Kim (University of Michigan), Scott Duncan (Mayo Clinic), Jeff Lawton (Cleveland Clinic), Peter Stern (University of Cincinnati), Greg Merrell (Indiana Hand Center), Ruby Grewal (University of Western Ontario)

Table 1

Comparison of Total Cost, Utilities, and Incremental Cost/Utility Ratios across Age Groups for the Treatment of Scaphoid Fractures

Age	Total Cost*	QALYs	Total Cost	QALYs	ICUR: ORIF vs. Casting
25 years	$7,940	25.89	$13,851	25.68	ORIF dominates†
35 years	$7,940	23.27	$13,851	23.09	ORIF dominates
45 years	$7,940	19.77	$13,851	19.63	ORIF dominates
55 years	$7,940	15.07	$13,851	14.97	ORIF dominates
65 years	$7,792	8.74	$13,651	8.7	ORIF dominates

ICUR, incremental cost/utility ration; ORIF, open reduction and internal fixation; QALYs, quality-adjusted life-years.

*Total cost includes lost productivity and direct medical costs

†A dominant strategy is defines as one that is less costly and more effective

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