Regionalized Health Care and the Trauma System Model

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This is the 119th presidential address to one of the oldest surgical societies in North America. The "Western" was founded in 1891 in Topeka, KS, which at the time was indeed a western outpost in the United States. Originally intended to have a geographic distribution of states bordering on and west of the Ohio and Mississippi Rivers and their major tributaries, the association now has no geographic constraints. We have held continuous annual meetings since 1891, with the exception of 1943. My first meeting was in 1984, as the guest of Dr Dale Liechty (president, 1986), at the Broadmoor Resort in Colorado Springs, where we have held 13 annual meetings, making it the most common meeting site for our organization. In the past 3 decades the members and leadership of this organization have influenced my professional career, research, and clinical care activities. The famous camaraderie in this association has nourished my enjoyment and love of academic surgery and maintained my knowledge and education in the broad area of general surgery. The "Western" has also afforded me tremendous opportunities and you have greatly honored me with your trust and recognition, and I thank you.

I also want to publically thank the chairmen of surgery who have directly or unknowingly perhaps allowed me this honor. John Najarian at Minnesota and Tom Starzl at Colorado so strongly influenced my medical school and surgical residency training that I seriously considered a career in transplant surgery. But the influence of the trauma surgeons Bill Curreri, C James Carrico, and E Gene Moore led me to a career in trauma and acute care surgery. My chairman for the last 15 years, Carlos Pellegrini, has been an influential role mode and mentor in the finest tradition, combining a remarkably insightful and dedicated leadership with sincere personal attention to his entire faculty. My academic career also owes much to Ron Maier, Fred Rivara, and Ellen MacKenzie and the entire acute care surgery faculty at Harborview Medical Center in Seattle. I believe our collaboration and friendship sets a benchmark for how to make an academic career enjoyable, productive, and meaningful. I have indeed been fortunate.

The purpose of this talk today is to examine why regionalization of health care has become so ubiquitous in medical system discussions, to explore in some detail the trauma model of regionalization, and to propose a national acute care surgery regionalized care model. Regionalization of health care is part of the larger dynamics of change in medicine that includes demographics, financing, and generational identity issues of physicians in training and future providers of care. Trauma systems, I believe, provide a model for effective regionalized care, and I will propose a national acute care surgery network of hospitals built on this model. But there are lessons that can be learned from 35 years of trauma system development and implementation, and regionalization is not appropriate for all of medical care.

MONEY: FINANCING HEALTH CARE

The financing of health care in the United States is poised to undergo another major change, with ramifications affecting how care is delivered that are likely to rival the changes brought about by the Johnson-era establishment of Medicare and Medicaid. At a time when our national debt ($14 trillion) is about equal to our gross domestic product (GDP), the pressure to reduce spending (and increase revenue) are likely severe enough to bring about change. The total federal dollars spent on health care represent about 17% of GDP, and our per-capita spending of more than $7,500 makes the United States one of the most costly health care countries in the world (Figs. 1 and 2). The rate of growth of health care expenditure shows no promise of abating, as our population ages and the majority of health care dollars are spent on the elderly. In January 2011, a federal bipartisan commission on debt reduction recommended a $200-billion reduction in health care expenditures by cutting federal spending on graduate medical education, expanding accountable care organizations to include bundled payments, making cuts to Medicare Advantage, home health care, and disproportionate share payment, and placing more Medicaid patients in managed care organization (Table 1). The Heath Care Reform and Affordable Care Act passed in 2011 was insightfully and objectively reviewed by Mike Farnell in his 2010 Western Surgical presidential address, and is a major interest of the American College of Surgeons Health

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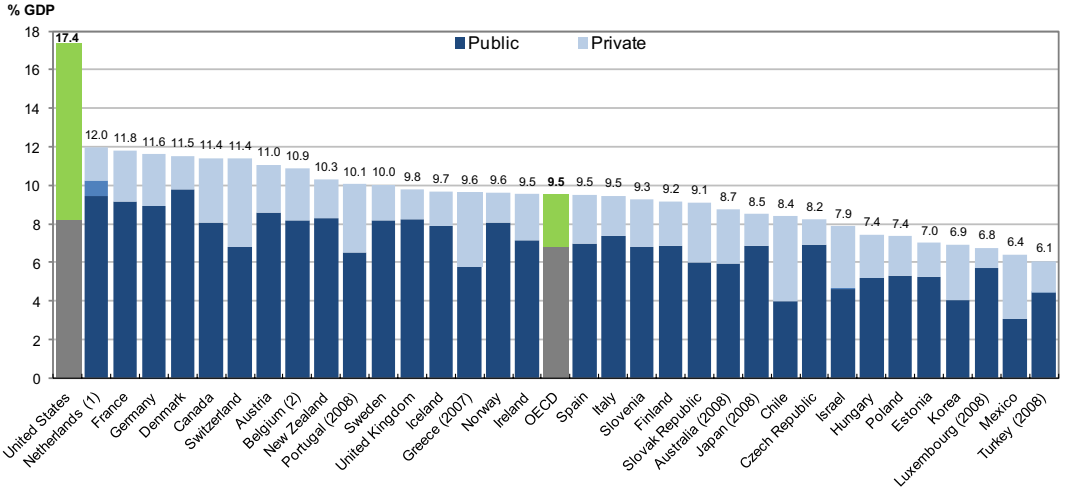

Figure 1. Total health expenditure as a percent of gross domestic product, 2009. United States is highest at 17.4%. Organization for Economic Co-operation and Development (2010), doi: 10.1787/data-00350-en (Accessed February 14, 2012). (Reprinted from: OECD Health Data, OECD Health Statistics [database], with permission.)

Policy Research Institute.[1] A very basic assessment of these issues indicates there will be fewer federal dollars for health care, and those dollars will be tied to performance, outcomes, and patient safety issues.

DEMOGRAPHICS: CHANGING WORK-FORCE PICTURE

The second major force that is influencing the delivery of surgical care in this country is the changing demographics of the new physicians. The loss of the general surgeon in the workforce has received much attention, with data demonstrating a 2.3% actual loss in general surgeons between 1996 and 2006, or a fall from approximately 27,000 to 25,000 general surgeons, despite a rising numbers of other primary care providers and of all specialists (Fig. 3). Future projections are no better, with a predicted 10.8% drop in overall surgical workforce by 2025, with the steepest loss in the coming 5 years. A widely accepted benchmark for general surgeons is 6.5 per 100,000 population. In 1981 there were 7.68 general surgeons per 100,000 population, falling to 5.69 per 100,000 in 2005.[2] The relative number of general surgeons in the United States has fallen by 25.91% since 1981. Wide variability in distribution of the general surgeon workforce is evident in all studies, but the rural areas are seeing the steepest decline to what has been characterized as critical shortages of surgeons.[3] In part, this is attributed to the aging of baby boomers and with them, the aging of a generation of general surgeons (Fig. 4). But it is also attributed to a static number of medical schools and falling MD enrollment per 100,000 population (Fig. 5). The Association of American Medical Colleges (AAMC) Center for Workforce studies document a decline in medical school enrollment from 7.3 per 100,000 population in 1980 to 5.6 per 100,000 in 2005, with prediction of further decline to 5.0 per 100,000 in 2020. Clearly, a career in medicine is not as attractive as it once was. The specialization of the surgical workforce is also pivotal. The proportion of general surgical residents who go on to pursue fellowship training has increased. In 1992, 55% of surgical residents went on to specialty training compared with 70% to 80% at the current time. Because there are slightly less than 1,100 new general surgeons trained each year in the United States, only about 300 remain as general surgeons.[4,5]

There is also a growing influence of women in the surgical workforce. In 2010, 26.5% of the surgical residency graduates taking the American Board of Surgery certifying examination were women, but between 39% and 42% of residents taking the in-service examination are women. Since 1970 the total number of women entering and matriculating from US medical schools has also increased every year. Women went from less than one-third (31.4%) of all matriculates in 19821983 to a high of 49.6% in 2003–2004. In 2010–2011, women represented 46.9% of all matriculates.[6] This gender influence is not confined to medicine, of course. Since 1950 in the United States the proportion of women in the general workforce has grown from 27% to just under 50%.

GENERATIONS: CHANGING EXPECTATIONS AND MOTIVATIONS

What are the major concerns, desires, and hopes of this newest generation of surgeons? In 2001 Grabram and colleagues[7] surveyed 111 recent surgery residency graduates, 77% male, and found that financial issues and

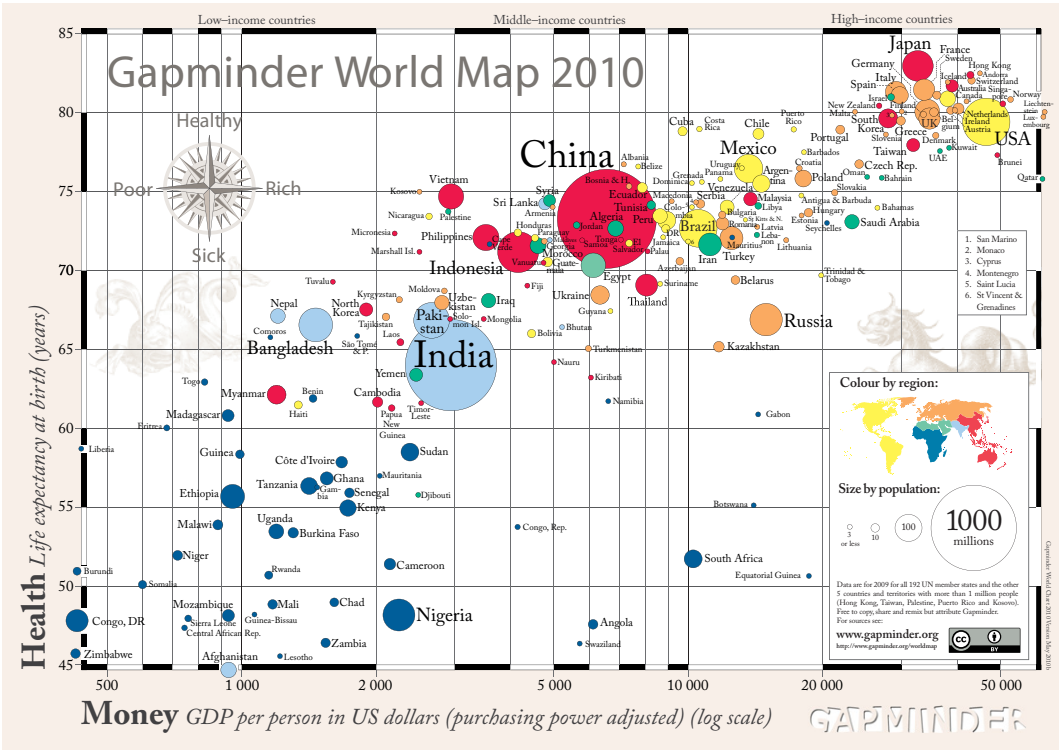

Figure 2. Wealth and health of nations: life expectancy vs. gross domestic product. Available at: http://www.gapminder.org/data/documentation/gd004/. Accessed February 14, 2012. (Source: free material from www.gapminder.org, reprinted, with permission.)

family plans and work hours represented 6 of the top 10 concerns. A joint Association of American Medical Colleges/American Medical Association 2006 survey of physicians under the age of 60 demonstrated that work-life balance is more important than income for women physicians.[8] Time for personal and family life, flexible scheduling, no call, and minimal practice responsibility have the highest appeal to women; men are more motivated by current and long-term income potential.

Table 1. Recommended Cuts in Federal Health Care Expenditures from 2012 to 2020

Data Shot, Debt Commission Recommendations: the heads of a bipartisan federal commission on government spending recommended a number of health care spending reductions, including (in billions):	
Cut federal spending on graduate and indirect medical education.	$54
Reduce taxes that states may levy on Medicaid providers.	$49
Expand ACOs, payment bundling, and other payment reform.	$38
Accelerate phase-in of cuts to DSH payments, Medicare Advantage, and home health.	$37
Cut Medicare payments for bad debt.	$15
Place dual-eligible individuals in Medicaid managed care.	$11

ACO, Accountable Care Organization; DSH, disproportionate share hospital. (From: The National Commission on Fiscal Responsibility and Reform, The Moment of Truth, The White House, Editor. Washington DC: December 2010; 1–66. Available at: www.fiscalcommission.gov. Accessed April 2, 2012.)

In perhaps the best assessment of attitudes of general surgery residents, Yeo and colleagues[9] surveyed more than 4,400 categorical residents of all levels in 2008, representing 82% of all the residents and virtually every training program in the country. The good news from that survey is that 95% of residents like their jobs, their programs, and their fellow residents; and about 90% of residents are satisfied with their operative experience and technical skills, and feel the work is worth the reward. But a substantial majority (net 29% over neutral) believe that they must become specialty trained to be successful, to be competitive in the market place (net 43% over neutral), and in doing so, will have a better lifestyle (net 51% over neutral). This should not be surprising given that there has been an explosion of medical knowledge and information, there is less training time to learn and master this body of information, and most residents are trained in university-affiliated institutions where nearly all surgeons have developed niche practices

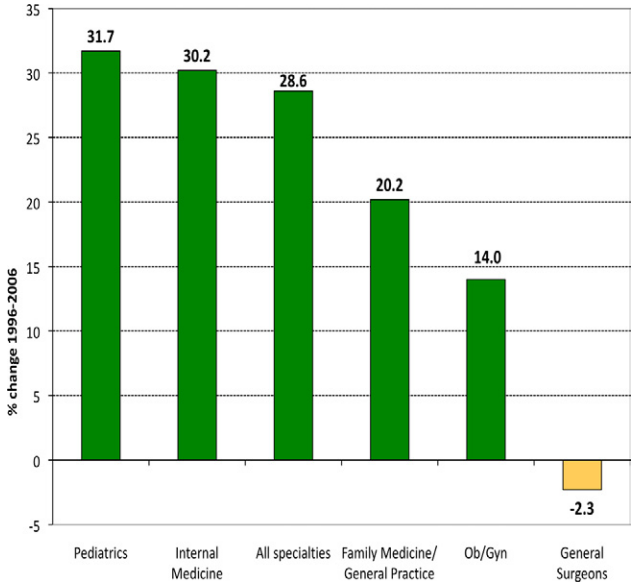

Figure 3. Decreasing general surgeon work force. (Reprinted from: Association of American Medical Colleges, Center for Health Workforce Studies, 2008 Physician Specialty Data, November 2008, with permission.)

that are highly specialized with remarkably challenging clinical scenarios and generally superb outcomes.

Much has been said and written about the generational differences that are altering the American work force in this early part of the 21st century.[10-12] The workplace still has a substantial number of baby boomers, many in leadership positions, but more and more the Generations X and Y are influencing the dynamics of work. Although there is considerable overlap, social scientists have some disagreement on the exact descriptions, baby boomers are those born between the years 1946 and 1964; Generation X born between 1964 and 1984, and Generation Y between 1985 and 2005. Generation Y is also referred to as "Millennials" (turned 21 after 2001), Net or Next Generation, or "Echo-Boomers. The importance of these generation perspectives on life, living, and work place should not be underestimated as forces that influence career selection, job satisfaction, and priorities in life. Unquestionably, the younger workforce is not nearly as loyal to their employer and certainly less willing to sacrifice personal and family life for career demands. They also tend to value friends over all other relationships, and have an expectation of being told exactly what is needed of them, and rewarded for accomplishing just that. Other influential characteristics of Generation Y is that they are generally optimistic, team-oriented, innovative, and environmentally conscious.[7,9,13-15]

REGIONALIZATION: EPOCHAL TRANSFORMATION OF MEDICINE

These demographic and social forces, mixed with a changing surgical training environment and fostered by the expectations of patients, combine to encourage specialization of practice for the majority of surgical training graduates.

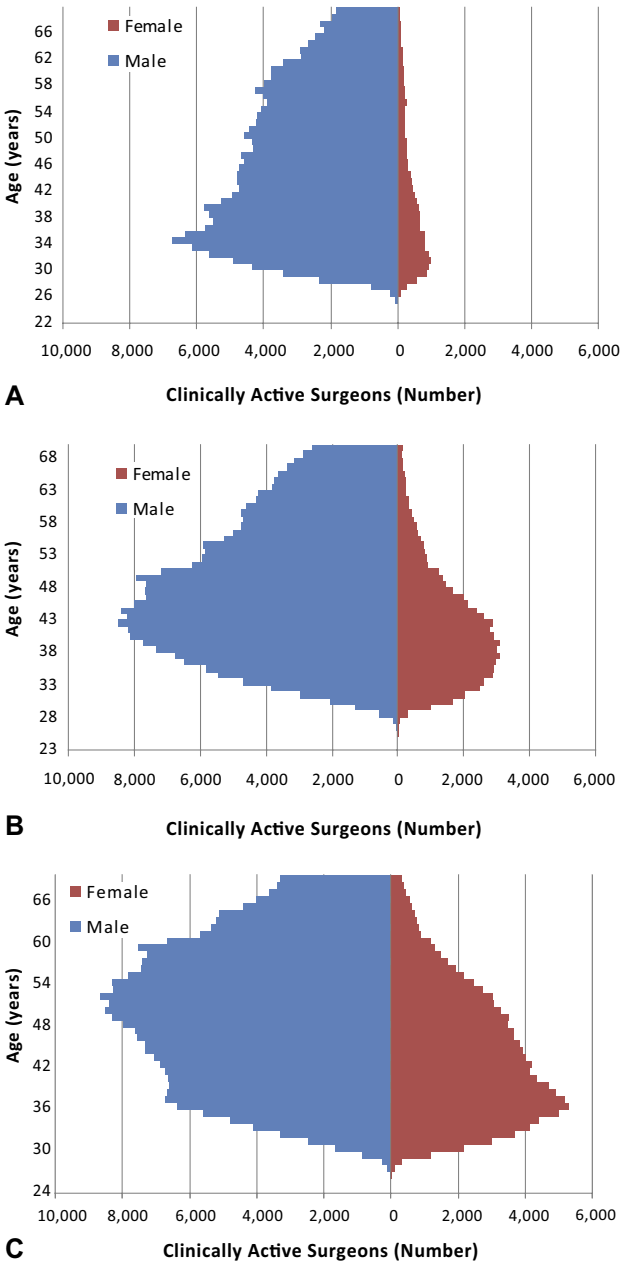

Figure 4. Age and gender trends in American surgeons. AMA Master file, all surgeons: (A) 1981; (B) 1996; and (C) 2006. (Reprinted from: George Sheldon, MD. The millennium generation & health reform: GME and beyond. 2011 Clinical Congress, American College of Surgeons Health Policy Research Institute, with permission.)

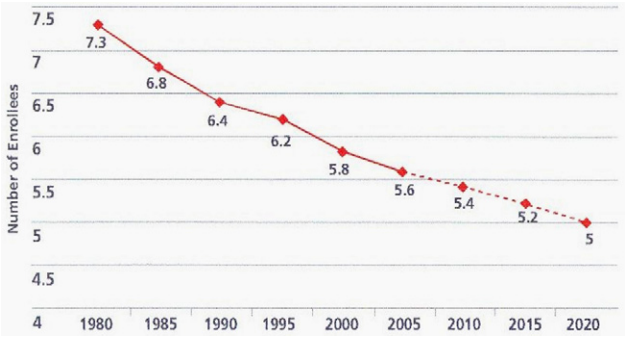

Figure 5. First-year MD enrollment per 100,000 population has declined since 1980. (Reprinted from: Association of American Medical Colleges; U.S. Census Bureau, prepared by the Center for Workforce Studies, AAMC, February 2006, with permission.)

General surgery has become a vanishing practice, being replaced with surgeons who focus their efforts on an expanding variety of niche practices: hernia, breast, endocrine, surgical oncology, colorectal, vascular, and laparoscopic or minimally invasive gastrointestinal surgery. To be sure, the broad-based and broadly trained general surgeon remains the linchpin of every rural hospital and certainly has not disappeared from practice. Yet with specialization and with the falling number of general surgeons has come a dramatic decline in surgeons willing to take call — that most basic of responsibilities to provide surgical care for any number of unattached, often under- or uninsured, surgical urgencies and emergencies.

This problem has been noticed since the beginning of the 21st century and has received considerable attention from a wide variety of public and private organizations and governmental agencies. The cover story of *US News and World Report* in 2011 was entitled, "Crisis in the ER." The Robert Wood Johnson Foundation report authored by Rao and colleagues[3] in 2011 highlights the shortage of surgeons who take emergency call and suggests that "three-quarters of the nations' emergency departments do not have enough on-call coverage by surgical specialists to meet the demand for round-the-clock specialty care." The influential Institute of Medicine (IOM) 3-volume report in 2009 entitled, "Future of Emergency Care," noted that hospital-based emergency care was at the breaking point, with overcrowding of emergency departments, boarding of patients in the emergency department, ambulance diversion, and uncompensated care being the most pressing problems.

One of the key suggested solutions in the Institute of Medicine report was to regionalized on-call specialty care services. The concept here is that if many hospitals cannot find willing (or able) surgical coverage for certain surgical urgencies or emergencies, then the patients should be sent to regionalized centers of care that can provide these services. The burden on the patient is significant: moving great distances to receive health care. The burden on the receiving hospital is also significant: the patients often are the most challenging and underfunded in medicine. The burden on the profession of surgery is also significant, if often overlooked: a further erosion of the perception of our profession as one concerned primarily about the sick and suffering to one more concerned about themselves, lifestyle, and income. Nonetheless, this does appear to be the best model for the future of surgical care. The purpose of regionalization of care is to consolidate complex and high technology medicine into regional centers with adequate surgeons in all specialties, in the hope that this will ensure quality and cost-effective care. It is an opportunity for surgical leadership to become involved in this dramatic change in medicine.

REGIONALIZATION: CONCENTRATION OF CARE IMPROVES OUTCOME

Regionalized care is certainly not a new idea. The concept that the more you do of something complex the better you get at it is intuitive, and that is the underpinning of regionalization and volume performance. Harold Luft is generally credited for bringing the concept of volume performance in medicine to modern discussions. In an article in 1979 he and his colleagues demonstrated that hospital volume with complex surgical cases was directly related to outcomes, and in a subsequent article in 1987 demonstrated that the volume of cases an individual surgeon performed was also a measure of quality.[16,17] John Birkmeyer is probably most well known to surgeons for a number of articles that looked closely at this concept of volume performance for surgical care. An important one published in 2002 examined hospital volume and surgical outcomes for a large number of cardiovascular, thoracic, and abdominal operations.[18] In this nationwide review of outcomes, mortality improves with increasing volume performed at medical centers. The question of whether it's the medical center or the individual surgeon volume that most affects outcomes remains unresolved. One article by Birkmeyer and colleagues[18] makes the point that it's the surgeon that's more influential than the center, but others have made just the opposite point, that it's the volume of the overall center and not so much the volume of the surgeon.

Massarweh and colleagues[19] from the University of Washington have challenged the concept of regionalization improving the overall health of Washington State residents by examining the Leapfrog volume criteria for pancreatic resection, abdominal aortic aneurysm surgery, and esophageal resection. Their data demonstrate a concentration of esophageal and pancreatic operations at a few centers (but

not abdominal aortic aneurysm), but disappointingly, there are no improved outcomes for all patients with these diseases in the state over this time period. An explanation for this finding might be found in the report by Stitzenberg,[20] which talks about the selective triage of patients to regional centers based on demographics and economics, not disease states. In this article, patients of black race, with poverty level income and lower insurance status were less likely to receive care in a high volume center. It is possible that for elective procedures (such as oncologic operations), the only people who get access to high volume centers are the ones with health insurance, less overall risk, and those who can afford to travel and have good support structure. This would imply that those most vulnerable to worse outcomes are kept at lower volume centers. That's not regionalization, and that is certainly not good for the population as a whole. That's just concentrating the richest and the wealthiest in a few specialized hospitals, and not improving quality or making more cost-effective overall health care.

The pros and cons of regionalization are also global in nature. Dr Ingemar Ihse's presidential address to the European Surgical Association talks about the issues that are driving regionalization in Europe.[21] He makes the point that hospital team volume and individual surgeon volume are probably both important, and I would agree with that. He also makes the uncomfortable point that intrusive regulation is likely required to bring about real regionalization. I also agree with that, and the trauma system is an example of state and national governmental regulation being required to have a well-functioning system. Two of the unresolved issues in these discussions are how far a patient is willing to travel to be treated at a center or by a surgeon who has marginally better outcomes statistics, and how cost effective is regionalized care if transportation costs, and family disruption costs are considered?[20,22]

REGIONALIZATION: THE TRAUMA SYSTEM MODEL

I want to try to make the point, and I hope I can convince you, that regionalization of trauma care does work, that it is true regionalization, and that it does save lives. Successful trauma care is largely time sensitive. If you can shorten the time window from injury to definitive care, you can expect a better outcome. This has been referred to as the "golden hour" of trauma care. This tenet has been touted and taught to us by military surgeons.

During the American Civil War, the time from injury to definitive hospital care was measured in days, with a concomitant 25% mortality. The 2 great world wars saw many improvements in care (motorized vehicles, forward medics, plasma, antibiotics, hemostatic dressings) and mortality of the injured continued to fall to 8.6% and 4.5 % as transportation times fell from 8 hours to 4 hours, respectively. Civilian trauma care was not up to military standards until after the Korean War and Vietnam conflict. Those battlegrounds set the stage for forward skilled medics, helicopter transport, and surgeons dedicated to caring for the injured who returned to civilian practice. Vietnam War mortality was under 2%, enviable by today's urban trauma center statistics, with time from injury to definitive care at 30 minutes, consistent with the urban 10:10:10-minute respond, field care, and transport goals. Further advances in field trauma care during the Iraq and Afghanistan conflicts have placed a new definition on prompt scene care, triage, and regionalization, with injury mortality from wounds reported at an incredible 1.7%.[23]

Civilian care of the injured at the scene was spurred by demonstration of the efficacy of mouth-to-mouth resuscitation and cardiopulmonary resuscitation by Peter Safar in 1958, and the subsequent development of paramedics and urban emergency medical services (EMS).[24-26] Although initially developed for cardiac arrest patients, emergency medical services quickly developed into field trauma care providers. In 1966 a sentinel "white paper" entitled, "Accidental Death and Disability: The Neglected Disease," by the National Academy of Sciences called attention to trauma as a major medical disease in this country that was largely being ignored.[27] In 1972, the Emergency Medical Services System (EMSS) Act (PL93-154) established federal guidelines and funding for regional emergency medical service. The organization structure (and some federal funding) for these agencies exists today.

In 1976 the American College of Surgeons Committee on Trauma published the first version of "The Optimal Resources for a Hospital." The 8th version is to be released shortly. This is the bible of how to function as a trauma center. Initially developed to serve as a guideline for what resources a hospital is supposed to have to be a trauma center, a name change in 1990 to "Resources for Optimal Care of the Injured Patients" expanded the implications and reach of these guidelines.[28]

What is the evidence that trauma centers save lives? The evidence that trauma centers save lives comes from 4 distinctly different sources of data: preventable death studies, registry comparison studies, population-based studies, and the National Study on Costs and Outcomes of Trauma (NSCOT).[28]

Preventable death studies dominated the literature in the 1960s and 1970s, with approximately 50 studies published that consistently demonstrated remarkable 50% to 70% drops in mortality after a hospital became a designated trauma center.[29-31] Registry studies compared an individual

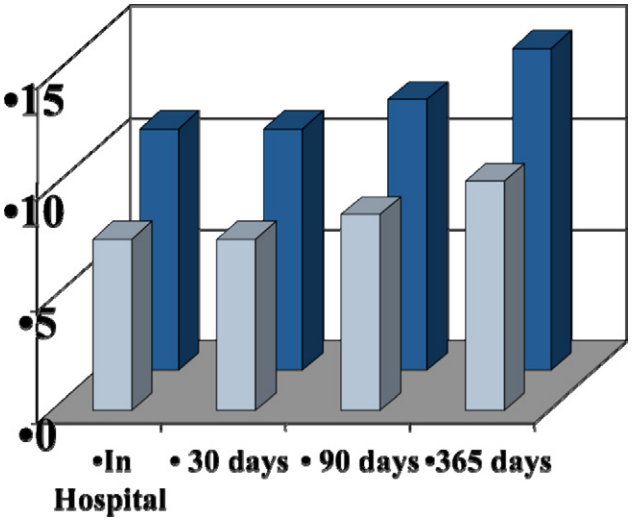

Figure 6. Survival advantage of trauma center care vs nontrauma center care. Mortality (%) vs time from injury. Data from MacKenzie EJ, Rivara FP, Jurkovich GJ, et al.[38] Light blue bar, trauma center; dark blue bar, nontrauma center.

hospital outcome with a national sampling of trauma centers or hospitals. The first national trauma registry was the result of the federally funded Major Trauma Outcome Study, MTOS, and publications from 1980s primarily were comparisons with this database.[32-34] In the mid 1990s the American College of Surgeons Committee on Trauma developed the National Trauma Data Bank (NTDB), which now contains data on roughly 1 million patients from the past 5 years on a rolling basis. Individual centers (and surgeons) can compare their results with the NTDB, and again, hospitals that develop trauma systems of care show improved mortality.

The third type of data supporting trauma center care is based on comparison of large populations. These suffer from the lack of individual patient detail, but have the advantage of looking at the outcomes and health of entire populations. As an example, Mullins and associates[35-37] compared the health of Oregon trauma patients with that of Washington State trauma patients during a time when Oregon had an established regionalized trauma system, and Washington did not. Because Oregon regionalized and concentrated trauma care, mortality of the population improved, and Oregon residents enjoyed a lower injury-related mortality compared with Washington State patients during a time in which Washington lacked a state-mandated trauma system. The final piece of evidence strongly supporting the efficacy of trauma centers is known as the National Study on Cost and Outcomes of Trauma (NSCOT).[38] Fifteen different regions in the country were involved, comparing outcomes from similar patients treated at 18 level I trauma centers and 51 modest to high volume nontrauma centers. Overall, 15,000 patients were examined in a prospective fashion over 18 months, then followed for 1 year after discharge. As demonstrated in Figure 6 and Table 2 mortality was significantly reduced by 20% to 25% for closely matched patients treated at the trauma centers compared with the nontrauma center. Younger and more severely injured patients benefited the most, with a 35% to 47% reduction in mortality in the more seriously injured subsets.[38]

What makes trauma center care better? Is it larger volume of patients, more resources, residents, and nurses? Is it better ancillary support or faster times from injury to the operating room? Increasing volume certainly seems to be one of the advantages of trauma center care. In a study of 31 academic level I trauma centers, the higher volume trauma centers (>650 major trauma admissions per year) had improved outcomes, particularly for the sickest of patients.[39] Improved critical care also seems partially responsible for better outcomes at trauma centers. The ability of trauma centers to salvage patients with complications or severe shock and injury appears to be a defining characteristic, and interestingly, trauma intensive care units that are "closed" and staffed by surgical critical care surgeons achieve the best results.[40-43] Although trauma centers do have better outcomes for patients requiring urgent surgery, it is not because they are any quicker at getting a patient from the emergency room to the operating room.[44] Complex pelvic injuries, spine injury, and some urologic injuries also appear to do better at trauma centers.[45,46] Suffice it to say the reason trauma centers have improved outcomes appears to be multifactorial, injury pattern dependent, and not entirely defined. It appears it is not just the hospital designation that makes the difference, but the design and effectiveness of system integration that is equally important.

In the year 2000 approximately one-half of the states in

Table 2. Survival Advantage in Trauma Center vs Nontrauma Center

Total NSCOT population (n = 15,009)	In hospital	30 d	90 d	365 d
Dying in nontrauma center, %	9.5	10.0	11.4	13.8
Dying in trauma center, %	7.6	7.6	8.7	10.4
Relative risk of death (95% CI)	0.80 (0.066,0.98)	0.76 (0.58,1.0)	0.77 (0.60,0.98)	0.75 (0.60,0.95)

Data are from MacKenzie EJ, Rivara FP, Jurkovich GJ, et al.[38]
NSCOT, National Study on Costs and Outcomes of Trauma; NTC, nontrauma center; TC, trauma center.

this country had statewide trauma systems that met federal guidelines of functional trauma systems.[47,48] We examined motor vehicle crash fatalities in those states with a trauma system, compared with states without a trauma system. The analysis was controlled for population age, speed laws, restraint laws, miles driven, and rural nature of the state. States with an intact trauma system had an overall 9% lower motor vehicle crash mortality, and about a 25% improved mortality for the most severely injured.[49] Fascinatingly, this improvement in mortality was not manifest until the trauma system had been in place for 8 to 9 years. It takes time for a regionalized system of care to mature.

Washington State is a good example of this progressive regionalization of trauma care and improved outcomes. Washington State's trauma program was enacted with legislation in 1991, with the first trauma center verifications in 1993. The system is an inclusive one, with about 80 of the 120 acute care hospitals in the state participating as level I through V trauma centers; there is only 1 level I center for the state, allowing for efficient concentration of resources for the most expensive and highest level of care. Although it's a large state, 88% of the population is within 1 hour of a level I or level II trauma center, although only 39% of the land mass is within this 60-minute time window.[50]

Over the past 20 years, the citizens of Washington have seen a progressive lowering of the motor vehicle crash death rate, from 4.91 per 100 million vehicle miles driven to 0.94, significantly better than the national average of 1.27 deaths per 100 million miles driven. Washington has also seen strengthened drunk driving laws, primary and secondary mandatory seat belt laws, mandatory motorcycle helmet use, and of course, a maturation of the trauma system. This maturation is evident in a more consistent response to trauma alerts by surgeons, more patients entered into the trauma registry, and more uniform prehospital documentation. Remarkably, we have also seen a decrease in the percent of air transports from the scene, with a concomitant increase in injury severity of those transported by air. This has translated into a falling mortality that is most evident in the most severely injured. In 1995, 25% of patients with an Injury Severity Score of 16 or greater died; in 2009 that number was less than 13%. Although every level of trauma center has seen this improvement, the ability to risk adjust and compare outcomes at individual centers has allowed the state Department of Health to identify outliers in care and focus attention and quality improvement efforts at specific hospitals and regions.

Similar data analysis from Australia demonstrated a relative risk reduction of motor vehicle crash mortality of 44% and of closed head injuries of 38% after the establishment of a regional trauma system.[51] Likewise, in Quebec, Canada over the last decade there has been a stepwise progression of falling risk of death as their trauma system has matured in stages.[47]

These examples emphasize the point that it is a series of activities and actions that are required for regionalizing care, not simply forcing a specific population of patients into one hospital. Regionalization of trauma care includes injury prevention, prehospital phase, the hospital phase, rehabilitation, and returning back to work, and importantly, a method for assessing the system performance and identifying and fixing problem areas. An ideal trauma system provides that continuum of care and addresses the classic 3 phases of trauma mortality: acute scene deaths that can only be prevented, early deaths that involve improved prehospital and hospital care, and late deaths that involve critical care and long-term care and complication reductions. The model trauma system plan written by the Health Resource Services Administration (HRSA) in 1992, with help from the ACS Committee on Trauma and the Centers for Disease Control continues to serve as the benchmark for trauma system regionalization design.[52] This publication was based on work and definitions first described by West and colleagues,[53] and modified by Bazzoli and associates.[48] The essential components of a trauma system are as follows: designating hospitals that have a specific range of resources; proscribing prehospital triage protocols that allow the selective bypass of nontrauma centers or lower levels of care; requiring interfacility transfer agreements; quality assurance programs with teeth and the ability to impact change; regional or state-wide coverage; and, importantly, a limitation to the number of centers based on need for patient care. These steps are rarely accomplished voluntarily, but require governmental regulations that also provide financial incentives to cover the large number of uninsured trauma patients.

The effectiveness of this approach to regionalized care is remarkable. A recent article in *JAMA* looked at 2.7 million trauma patients from the National Inpatient Sampling (NIS) data between 1995 and 2003.[53] This study defined major trauma patients as those with a mortality risk of 10% or greater based on injury severity, as calculated using ICD-9-based Injury Severity Score (ICISS). The authors defined high volume trauma centers as those that treat 915 or more major trauma patients per year. In the United States, only 7% of hospitals meet this threshold, yet they provide 60% of the total major trauma volume care in this country (Fig. 7). That's effective regionalization. That's an effective concentration of resources that saves lives.

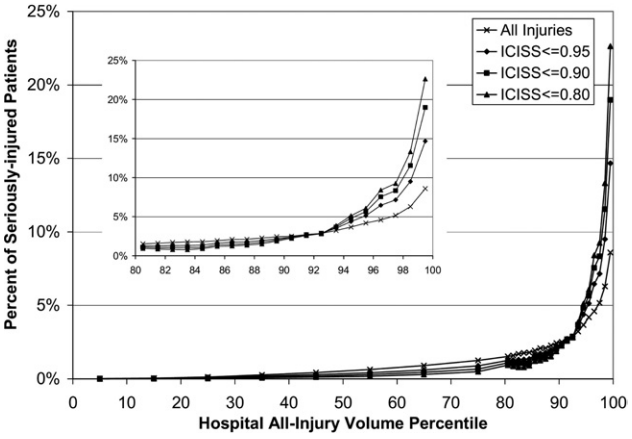

Figure 7. Percent of seriously injured patients seen at hospitals within each hospital all-injury volume percentile for 3 different definitions of seriously injured and for all injuries. Inset shows a detail of the top 20 percentiles of hospitals. ICISS, ICD-9-based Injuruy Severity Score. (Data from Diggs and colleagues.[54])

NATIONAL TRAUMA AND ACUTE CARE SURGERY CENTER NETWORK: A PROPOSAL

I am going to conclude with a proposal to create a national network of high volume, high acuity, trauma and acute care surgery medical centers. There are currently about 200 level I trauma centers in the United States; 107 of them are verified by the American College of Surgeons, the rest are verified by state agencies using similar criteria. The ideal population volume per level I trauma center is debated, but probably a minimum of 1 to 3 million people per level I trauma center is most appropriate. Any fewer and the volume of cases is diluted and efficiency of concentration and expertise is lost. Because the population of the United States is about 300 million, the ideal number of trauma centers would be between 100 and 300. I tend to favor fewer level I centers and a greater concentration of the most difficult cases and expertise, so for the purposes of this proposal, let's say 1 level I trauma and acute care surgery center per every 2.5 million people, meaning a network of 120 such centers across the country would be required. This density of trauma centers is readily met (and often exceeded) in urban and suburban environments, but is more difficult to achieve in the rural western states.

Staffing and resources for this national trauma and acute care surgical center would be consistent with what the American College of Surgeons requires for verification of level I trauma centers. From the standpoint of surgical coverage, a cadre of general surgeons with specific training and expertise in trauma, surgical critical care, and emergency general surgery— the acute care surgeon model—would be ideal coverage for this type of center.[55,56] Eight to 10 such surgeons, with resident and/or mid-level providers, would provide coverage for surgical critical care, emergency general surgery, trauma surgery, research and education, and administrative duties, implying a need for 960 to 1,200 such surgeons. These surgeons would provide primary surgical care for trauma, critical care, and emergency and elective general surgery, with 1 night per week of in-house call, time for research and administration, and adequate vacation and sick leave coverage.

Focusing the new generations of surgeons in this national network of trauma and acute care surgical centers could be made attractive to the best and brightest with a number of incentives. Loan forgiveness programs for medical school education could be applied to surgeons working in such centers. Volunteers could be recruited, perhaps establishing an AmeriCorp for physicians. With adequate manpower, fixed time off, set schedules, and protected time after night coverage and for academic activities would be easier to arrange. Fixed minimum incomes with volume and work performance incentives could be applied. Malpractice limits, similar to the protection state and federal agencies enjoy, could be applied. Such networks could readily become academic centers of excellence. The academic productivity and clinical research material from a well organized network of such facilities would be phenomenal, and would serve as the model for multicenter trials and studies of a wide array of interventions, procedures, and practices. Standardization of care would be much easier to obtain, as would dissemination of new information and practices.

The cost for this national network of trauma and acute are surgery centers can be estimated, if only on the back of a napkin at this point. If each hospital had about 300 to 400 beds and an estimated annual operating budget of $600 million, the total operating costs for 120 such centers would be $72 billion. If one-half of that money came from third-party health care insurance sources, the federal costs would be $36 billion, certainly less than the $50 billion proposed in the 2012 Veteran's Administration budget for direct medical care.[57] This can also be compared with the wide range of public dollars spent by communities to provide safety-net coverage. As an example, the city and county of Denver budgets about $27 million annually to Denver Health, while the city of San Francisco supports San Francisco General with about $38 million annually from their general fund.

How close are we to having the manpower to meet the needs of such a network of hospitals? Over the past 4 years, 10% to 12% of the current 1,100 graduates of general surgery training programs go on to do a surgical critical care residency. That's actually more than or equal to vascular, pediatrics, hand, or thoracic surgery specialty training. In 2009 there were 2,583 surgeons who have their board in surgical critical care, and 1,204 of them have

been recertified at least once.[58] In addition, there is the ongoing development of acute care surgery training programs, spearheaded by the American Association for the Surgery of Trauma, with a goal of 20 to 30 such training programs.[55,59-61] So we have the manpower, and we have a great distribution of trauma centers across this country, with authoritative legislation in most of the states. Eighty-three percent of the population is within 1 hour of trauma center care by ambulance or helicopter.[50] Western rural states have the unsolved problem of adequate access to trauma center care, primarily because the population density cannot support such highly specialized centers. But with improved organization of regionalized transportation, this could be solved and these patients and resources concentrated. Urban America has a different problem in some locations, and that is the oversubscribing of trauma centers due to ego, greed, lack of cooperation, and presumed prestige. This too could be solved with legislation and changes in funding for trauma and acute care surgical issues.

I want to conclude with the thought that trauma care systems are a model for regionalization of all time-sensitive illnesses, not just trauma, and not just surgical issues; the integrated trauma system model can be the future of regionalization of all health care.

As Vice-President Jim DeBord said, it's a long way from Aurora and the iron mines of northeastern Minnesota for this boy standing at this podium and in front of this audience. Throughout this journey I have been blessed with much support from colleagues and mentors, and much love from family and friends. But the heart and soul and love of my life are sitting here at the front, my wife and 3 daughters, and I certainly wouldn't be in front of you without them. Thank you for the great privilege of serving as your president.

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