Psychological Health in the United States Military: Making Sense of What We Know

John Hess, Cody Kamin, C. Robert Kenley
Massachusetts Institute of Technology
{johnhess, ckamin, kenley} @mit.edu

Abstract. Hundreds of thousands of members of the United States military service are suffering from post-traumatic stress and other psychological health conditions as a result of their wartime service. A myriad of possible system interventions and resource allocation schemas have been researched and proposed, but finite budgets and personnel levels dictate a careful allocation of resources to optimize outcomes. We describe a stock-and-flow model of psychological health treatment tailored to the unique context of the US military's healthcare system. Our model, implemented as a management flight simulator, reports the impact of system interventions on areas of stakeholder concern and is designed to communicate complex systemic behaviors to those without domain-specific knowledge.

Introduction: An Unfamiliar Fight

The United States' military is recognized by many as one of the greatest fighting forces in history. In March of 2003, as expected, the US military and allied forces operating as Multi-National Force – Iraq defeated the Iraqi armed forces during the invasion of Iraq. Soon after, however, all of this might was unable to defeat the new enemy, the burgeoning insurgency. For years, the situation continued to deteriorate. However, the 2007 decisions by the US to increase manpower and adopt substantial strategic and tactical adjustments were viewed as a turning point, even by some of the war's most vocal critics. The common description of the changes, the single word "Surge", obscures many of the most important causes of the war's turnaround such as the adoption of counterinsurgency doctrine as a force-wide policy and fundamental changes in the attitudes of subsets of the Iraqi population.

With helicopters and medics standing by to evacuate wounded soldiers and hospitals capable of treating the most acute physical injuries spread around the entire planet, the US military's healthcare system is clearly a highly capable organization. But like their war-fighting capability in the early years of the wars in Iraq and Afghanistan, the military's healthcare system was designed to perform a specific set of missions, and was not fully prepared for the challenges it would face.

The growing number of mental health problems within the force has overburdened the military healthcare system, which was not designed or prepared to treat the large number of servicemen and women suffering from Post Traumatic Stress Disorder (PTSD) and other Psychological Health (PH) issues, the "signature wounds" of the wars in Iraq and Afghanistan.

The US Department of Defense and other institutions have responded with a concerted effort to understand the situation at hand (with over 900 current PTSD research projects nationwide), and determine the best path forward. A large base of fundamental research from civilian treatment has now been augmented by recent findings specific to the United States' military. Research has yielded a wealth of data and a substantial amount of information derived from it. As a result, countless system interventions have been proposed, but constraints dictate that not all can be fully implemented.

The Hard Facts

The US Department of Defense Mental Health Advisory Team found that 38% of soldiers (Army), 31% of marines, and nearly half of National Guard troops deployed in Iraq and Afghanistan reported psychological symptoms[11].

PTSD, an anxiety disorder that can result from combat stress, is a major concern for military leadership and the public at large, and is part of a range psychological health issues facing service members and their families. The yearly impact of lost productivity from military PTSD alone is in the billions of dollars[15]– and this does not begin to describe the true social costs borne by returning service members and their families.

Key Opportunities for Improvement

The US military's psychological healthcare system is ripe for improvement. Research to date has identified several failures within the system as well as several emerging opportunities for

intervention. The listing here is by no means exhaustive, but highlights some central concepts for those new to the subject.

Gaps in Access to Care and Quality of Care

Half of service members afflicted with PTSD do not receive help. Of those who do, almost half do not receive care that has been proven to be the most effective[15]. Many providers within the distributed (organizationally and geographically) military health system are unable to meet the growing demand for care. In many cases, even soldiers who do seek care are unable to find a provider with any availability. Inadequate staffing and funding surely contribute to this gap in access[11].

Prevention and Resilience

Across the services, several programs are aimed at preparing service members for combat stress and preventing PTSD[9,15,16]. These programs have the potential to have a major system wide impact by reducing the number of soldiers affected by PTSD and by reducing stigma.

Stigma

One of the most prevalent issues regarding access to care is the stigma associated with these conditions. The effects of social misconceptions about these disorders are magnified in the military, where individual strength is emphasized. Very large proportions of soldiers and marines report being unwilling to seek treatment for fear of negative repercussions. Service members fear losing the respect of their unit, looking weak, and negative career impacts[15]. Changes in stigma have the potential to drastically affect the number of active military personnel and veterans who seek care.

Challenges in Addressing Mental Health in the Armed Services

Policy makers and military leadership face challenging decisions in allocating resources and political capital to competing programs both within the US Military Health System and within the greater military. The former Chairman and CEO of Lockheed Martin, Norm Augustine, described a critical challenge faced in healthcare at large which is particularly relevant to the issue discussed here:

> *"Systems engineering has had an enormous impact in any number of fields, but at least from my perspective, it is only beginning to be applied in healthcare. Part of the reason, I suspect, is that so many of the issues in healthcare are difficult to quantify societal questions, such as, should you spend the next marginal dollar on prevention, on research, or on treatment of the stricken?"* [4]

To decide between so many seemingly worthy suggestions to improve the system, we must analyze their impact across a broad range of important areas. These include productivity, force readiness, costs, retention, and the moral imperative asserted by Admiral Mike Mullen, Chairman of the Joint Chiefs of Staff:

> *"This isn't just a debt of gratitude. This is a debt that must be repaid because they have sacrificed so much. They have done exactly what this country has asked. They have fought and suffered and their lives have been affected forever."*

Communicating and Understanding System-Level Impacts

Even for a subject matter expert, understanding the expected effects of various system

interventions can be daunting in a complex service system like healthcare. This is doubly so in the military where patients are also employees of the larger enterprise. Communicating these effects to stakeholders without domain expertise can be even more difficult. Research into the limits of human decision-making shows that mental models of complex systems are nearly universally insufficient[19]. With policy makers at all levels relying on abstractions of data and upon the information and knowledge generated by that data's analysis, we must be able to clearly communicate the insights generated by research[21]. Augmenting and correcting stakeholders' mental models will be essential to architecting a system that meets stakeholders' most important needs[18].

Successfully implementing solutions to the shortcomings of the military's psychological health care system will not rely on unilateral decision-making and orders passed down through the entire military. Instead, it will depend on addressing the needs of a host of stakeholders[13] including warfighters, their families, leaders and care providers in the Military Health System, providers in private practice, congress, and military leadership from the Joint Chiefs of Staff to the platoon level. An in-depth analysis of the stakeholders in this system can be found in Ippolito 2010, (also published in this conference's proceedings) [10].

Research in the field of management shows that organizations have difficulty understanding and managing systems that have long feedback delays[14] and slow-to-emerge secondary effects. The intuition that the processes of recruiting, training, deploying, diagnosing and treating service members can exhibit feedback delay is supported by research into the creation of epidemiological models described below.

Resource Modeling in the U.S. Military

Resource models are important tools that help allocate finite resources more effectively. In the context of military PH, resources in short supply include money, personnel, and private sector care capacity.

A Brief History of Military Healthcare Resource Modeling

Before the adoption of more sophisticated models, resources were allocated either subjectively or based on a set of standards and guidelines. In the 1970's the Army began making an effort simply to measure the current use of manpower in existing organizations[5]. In 1983 the Army Health Services Command adopted a set of standards to be applied by individual facilities to determine staffing requirements called the Manpower Staffing Standard System (MS-3)[20]. This system was not without its drawbacks. The very nature of standards encouraged hiring but never releasing staff. MS-3, therefore, was widely seen as ineffective[5].

In 1992, MS-3 was followed by the Benchmarking System developed by the Army Medical Department. The program was criticized as only focusing on very specific tasks within an MTF and not being thorough enough[20]. As a result, the program was short-lived and replaced (within the Army) by the more modern Automated Staffing Assessment Model (ASAM).

ASAM

ASAM is more sophisticated than previous attempts because it addresses the question of where to spend the next marginal dollar. The model projects the personnel needs for each type of staff based on patient-to-provider ratios. In other words, the model provided a basis by which to prioritize resources within a given military hospital, known as a *military*

treatment facility (MTF) [20].

The most important factor in ASAM's staffing projections is the size of the population being treated at an MTF. The model is also advised, to a much lesser extent, by population projections. ASAM uses industry performance data from outside the military to help determine staffing requirements for each medical specialty. ASAM can also be tailored to the characteristics of any given MTF such as patient-care hours, staff time spent performing ancillary duties, and the ratio of providers to support technicians. With this information the model reports back staffing requirements for each MTF a variety of medical specialties such as physicians, nurses, and dentists[6].

PHRAMS

In 2007, the Defense Health Board Task Force on Mental Health[1] recommended:

> "The Department of Defense should adopt a risk-adjusted population-based model for allocating resources to military mental health facilities and services embedded in line units. Allocations should be regularly reviewed to update risk assessments."

The Center for Naval Analyses was subsequently contracted to develop such a model. Their model, the Psychological Health Risk-Adjusted Model for Staffing (PHRAMS), projects staffing needs particular to psychological healthcare. This list is more thorough than psychological health staffing recommendations generated by ASAM because it accounts for more provider types[8]. However, PHRAMS does not account for costs the way ASAM does.

PHRAMS requires many of the same inputs ASAM does. It differs, however, in its consideration of risk-adjusted attributes of the beneficiary population. For example, PHRAMS takes into account untreated prevalence, deployment severity (to adjust for the increased risk resulting from multiple deployments), and two major avenues of care (i.e. direct care and purchased care).

Model Usage

ASAM and PHRAMS are used simultaneously within the Army. PHRAMS produces more refined estimates of PH staffing needs, but stakeholder interviews suggest these projections are infeasible. PHRAMS projections often greatly exceed the number of providers an MTF believes they can hire, especially when treatment facilities have competing needs for staff in other specialties. Unlike ASAM, which justifies its projection with a cost-benefit analysis, PHRAMS provides only a projection.

PHRAMS' more nuanced projections were designed to inform budget requests[8] (the lag between making a request and actually bringing new staff on board can be over a year). Unfortunately, these projections do not help stakeholders allocate the resources they actually have at hand.

A Mental Healthcare Flight Simulator

Management flight simulators are guided activities in which decision makers have the opportunity to experiment with various courses of action without real-world consequences[2]. Using management flight simulators that provide immediate feedback, policy makers and other stakeholders can improve their mental models of various phenomena[18]. Furthermore, rapidly simulating the effects of different policies enables informed communication and cooperation between stakeholders attempting to solve open-ended problems.

We are developing a management flight simulator for mental healthcare in the US military. The simulator will serve two purposes. First, it will support our team's broader efforts to architect the military psychological healthcare enterprise. We will be able to quickly examine the combined effects of varied efforts and refine our own mental models. Second, we will be able address two key problems associated with the models to date: their opaque nature and their failure to address the concerns of all stakeholders.

Using this tool, we will be able to more effectively communicate the rationale behind our recommendations and the consequences of alternate approaches. More importantly, the accessibility of this tool will allow stakeholders throughout the Department of Defense to evaluate the effects of any number of system interventions, and better learn the dynamics of the mental healthcare system.

An Example from a Domain with Similar Challenges: Climate Rapid Overview and Decision-support System (C-ROADS)

Like the challenge of delivering healthcare, solving climate change depends on creating a vision that will be embraced by stakeholders across the enterprise. The underlying scientific models of climate change are complex, and beyond the understanding of those without domain-specific education. There are countless possible input parameters and system interventions, and success is reflected in multiple metrics.

Available for public access at www.climateinteractive.org, C-ROADS is designed to aid policy makers and the public at large in understanding the temporal relationship between greenhouse gas emissions and global climate change.

The underlying system dynamics model is grounded in well-accepted scientific models and is consistent with the results of models used by the Intergovernmental Panel on Climate Change. Users can evaluate a wide variety of possible scenarios and watch as carbon buildup, global temperature, and sea levels all change over time[7].

We view C-ROADS as an exemplar model demonstrating flexibility and accessibility while clearly communicating otherwise unwieldy system behavior.

Our Implementation

Outputs

The design of our flight simulator began with an assessment of stakeholder value propositions and of probable gaps in their mental models. Designing our flight simulator with these outputs in mind allowed us scope our underlying model to a manageable level of complexity without sacrificing relevance. The most important outputs we identified were:

- *Service Members' Access to Care* – For service members and their families, a primary concern is their ability to seek care. Often, providers are overburdened and unable to take on new patients. These service members deploy and return home frequently (a full cycle is only 24 months), and eventually separate from the service. Because of this, they need timely access to care. We define access to care in terms of the percentage of afflicted individuals who receive treatment, the distribution of their waiting times and statistics on various circumstances that prevent them from receiving care (like deploying again before seeing a mental health professional).

- *Costs Incurred* – Direct and indirect costs are accounted for. Direct costs are measured as a change from the status quo (in this case, the current staffing levels and policy directives). Indirect costs include the loss of productivity (as described in RAND 2008) that military incurs while its service members are afflicted with a PH condition but not yet treated. Both direct and indirect costs are reported at organizationally relevant levels (such as the cost of care provided "in-house" vs. the cost of care provided by civilian providers in the "purchased care" sector).

There are ample opportunities to expand this model to account for a host of important outputs. Discussion of planned improvements to the model can be found in the "Future Work" section below.

Inputs

After analyzing the dependencies of our outputs, we identified a list of inputs most relevant to our model. They are:

- *Unit locations, populations, and deployment projections* – One unique aspect of the military healthcare is the constant geographic relocation of the system's beneficiaries. Active duty personnel can only be treated at an MTF when they are home from combat, and so we explicitly account for this window of time.
- *Unit deployment histories* – As one can infer from the higher incidence of PTSD and other psychological health conditions in the military, combat experience is an important predictor of an individual's risk. By utilizing data on the deployment histories of each brigade (in terms of the number of personnel on their first deployment, second deployment, etc.), we can more accurately predict the demand for care within each returning unit.
- *Separation rates* – Every day new service members join the military while others leave. While the population of the military as a whole might not change, its composition in terms of deployment histories and training received will change. Moreover, a person in need of treatment who separates may not be able to receive care when they leave the service, especially if they are not immediately employed.
- *Care Capacities* – MTFs, unit resources, and the private sector all have particular capacities for providing care (in terms of a rate of hours of care provided per day). Needless to say, this information is integral to our model.

The Underlying Model

At its simplest level, ours is a "stock and flow" model. We model the deployment and return of units and their resulting demand for care, and use that demand as the feed for a stock and flow process at a particular MTF (which might have several units which arrive and depart on different dates).

Rather than track beneficiaries as a cohort or a homogenous group, we track them as individuals with particular traits (resiliency training, deployment histories, treatment histories, wait time, etc.). This allows us to implement an added level of bookkeeping rather than simply recording inventories as a time series. We can keep track of each individual's experience including wait times or failure to receive care because of separation or deployment.

Behaviors Exhibited

This simulator demonstrates three behaviors that might not be captured in the pre-existing mental models of its users.

- *The Accumulation of a Patient Backlog* – Accumulation in the military health system is markedly different from traditional civilian centers. In typical healthcare scenarios, demand may change over time, but week-to-week variation is low (as dictated by the law of large numbers). On the other hand, because of the deployment cycle, the military health centers can see hundreds of new patients arrive on base over the course of a week. These new arrivals then wait in the backlog until they can be moved through the care system. Therefore, even when an MTF has the capacity to treat as many patients as it is expecting on an annualized basis, it cannot necessarily deliver timely care.

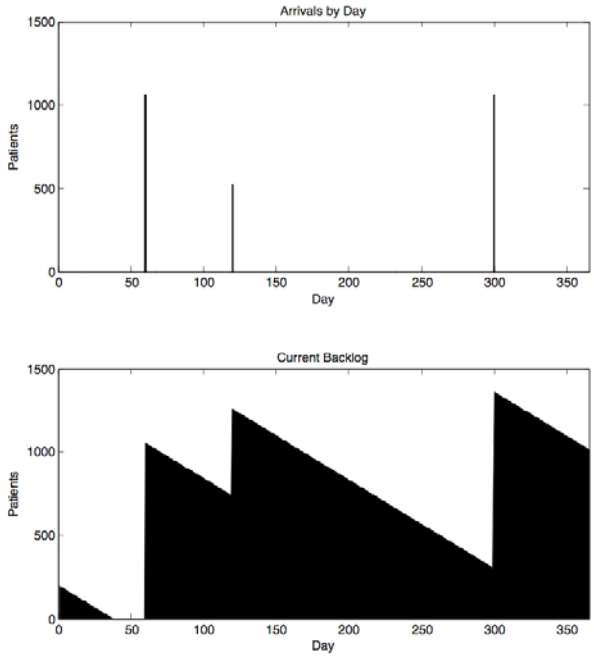

Figure 1: Arrivals and backlog by day in a simple case with no units deploying

- *The sensitivity of costs and outcomes to the amount of direct care and purchased care available and unit arrival times* – Direct care costs less to deliver than reimbursing a private provider, but it is not as flexible (not utilizing purchased care is free, whereas not accessing available direct care does mean the military does not pay those employees). Therefore, a base which has unit arrivals spread evenly can more cost-effectively utilize direct care where a base which sees concentrated arrivals will do better with more purchased care.
- *The systemic savings of treating patients* – The military, unlike civilian insurers, employs its beneficiaries and bears a direct cost in lost productivity when its service members are not treated. We have yet to fully characterize this behavior, but doing so will be important to the dialog between stakeholders with competing for money and manpower to accomplish their objectives.

Future Work

Over the coming months, we will continue the developing the model described here with the

goal being to model the behavior of actual bases and units (as opposed to the hypothetical scenarios used in the simulator). This will help us to examine real-world interventions and make informed recommendations about their systemic effects.

In addition to applying the underlying model to real scenarios as data becomes available, we will:

- *Continue to refine our inputs and outputs* – As we validate our assumptions and our outputs through stakeholder interviews, we will continue to refine them to ensure that we are addressing each stakeholder's concerns and that we are representing real life processes accurately.
- *Refine our Underlying Model* – Based on interviews and site visits to actual MTFs, we will refine the process depicted in our stock and flow model (currently a single treatment process) to include various assessments, referrals, pathways of care and treatment regimens. This will help us more accurately identify points for effective intervention such as reducing bottlenecks.
- *Account for Latency in Symptom Presentation* – Some PTSD patients do not show symptoms for month or years after their traumatic experiences. Others, especially within the military, wait to report symptoms because they fear career repercussions.
- *Address the Issue of Suppressed Demand* – Service members who do not seek care because they don't have access are not well accounted for[1]. We cannot confidently predict the amount of care that would be used in an unconstrained scenario (some will never seek care because of stigma, while others that wouldn't have received care because of access constraints would make use of additional capacity).
- *Account for the effects of resiliency training* – Resiliency training has been shown to reduce the impact of stress[16], and is therefore predicted to reduce the number of service members afflicted. It may also have the effect of reducing stigma and increasing the percentage of afflicted service members who come forward seeking care. These two changes may occur at different speeds. Making use of available data on resiliency programs may help us to predict what effect resiliency programs have on demand over time (for example, causing a short term increase, but long-term decrease).
- *Refine Analysis of Downstream Impacts* – Lost productivity is one of many downstream impacts of the PH system that face the military. Others include suicides, retention, substance abuse, and violent crime. Characterizing these costs to the military (and others to society) will be important to assessing the value of various interventions.

We also plan to validate the concept of our model and its results through interviews and the possible case study of a single MTF.

Conclusion

By modeling patient experience at a more refined level, capturing the systemic effects of decisions and demonstrating challenging-to-understand behaviors, our simulator should help and stakeholders within the U.S. military's psychological healthcare system to analyze and compare the systemic effects of resource allocation decisions and policy directives.

Augmenting mental models with a powerful but easy to understand computer model will

ensure that the “next marginal dollar” (or hour, or staffing billet, or piece of political capital) is better allocated.

References

1. Arthur, Donald C, et. al. “An Achievable Vision: Report of the Department of Defense Task Force on Mental Health.” 2007. Print. Defense Health Board.
2. Bakken, Bent, Janet Gould, and Daniel Kim. "Experimentation in Learning Organizations: A Management Flight Simulator Approach." *European Journal of Operational Research* 59.1 (1992): 167-82. Print.
3. Brennan, Alan, Stephen E. Chick, and Ruth Davies. "A Taxonomy of Model Structures for Economic Evaluation of Health Technologies - Brennan - 2006 - Health Economics." *Wiley Online Library*. 29 Aug. 2006. Web. 02 Nov. 2010. <http://onlinelibrary.wiley.com/doi/10.1002/hec.1148/abstract>.
4. *Collaborative Initiatives at MIT: New Models for Health 3 - Future Health Systems*. 18 Sept. 2008. Massachusetts Institute of Technology, Cambridge, MA.
5. Cooke, James. “Manpower Requirements Determination in the Institutional Army.” *USAWC Strategy Research Project*. 4 July 2003.
6. GAO, July 2010. "U.S. GAO - Military Personnel: Enhanced Collaboration and Process Improvements Needed for Determining Military Treatment Facility Medical Personnel Requirements." *U.S. Government Accountability Office (U.S. GAO)*. Web. 02 Nov. 2010. <http://www.gao.gov/products/GAO-10-696>.
7. Fiddaman, Tom, John Sterman, Andrew P. Jones, Elizabeth R. Sawin, and Lori S. Siegel. *C-ROADS: Climate - Rapid Overview and Decision-support Simulator*. *Climate Interactive*. Ventana Systems, 19 Dec. 2008. Web. 2 Nov. 2010. <http://www.climateinteractive.com>.
8. Harris, Daniel M. "The Psychological Health Risk-Adjusted Model for Staffing (PHRAMS)." Jan. 2010. Web. 2 Nov. 2010.
9. Helmus, T. C., and R. W. Glenn. *Steeling the Mind: Combat Stress Reactions and Their Implications for Urban Warfare*. Santa Monica, Calif.: RAND Corporation, 2005. As of March 13, 2008: http://w w w.rand.org/pubs/monographs/MG191
10. Ippolito, Andrea, and Jayakanth Srinivasan. *Stakeholder Theory to Better Under the Military Psychological Health Continuum of Care*. <Published in the proceedings of this year’s INCOSE symposium>
11. *Mental Health Advisory Team (MHAT) V*. 14 Feb. 2008. Print. Office of The Surgeon General, United States Army Medical Command.
12. *New Models for Health 3 - Future Health Systems*. 18 Sept. 2008. Massachusetts Institute of Technology, Cambridge, MA.
13. Nightingale, Deborah and Jayakanth Srinivasan. “Beyond the Lean Revolution: Achieving Successful and Sustainable Enterprise Transformation”. 2010. In Press.
14. Rahmandad, Hazhir, Nelson Repenning, and John Sterman. "Effects of Feedback Delay on Learning - Rahmandad - 2009 - System Dynamics Review." *Wiley Online Library*. Web. 02 Nov. 2010. <http://onlinelibrary.wiley.com/doi/10.1002/sdr.427/abstract>.
15. RAND. Monographs | Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery." Web. 03 Nov. 2010. http://www.rand.org/pubs/monographs/MG720/>.

16. Reivich, Karen J., Martin E. P. Seligman and Sharon McBride. “Master Resilience Training in the U.S. Army”. *American Psychologist* 16.1 2011. Print.

17. Rouse, William B. "Health Care as a Complex and Adaptive System: Implications for Design and Management." Web.

18. Sterman, John D. "Flight Simulators for Management Education." Web. 02 Nov. 2010. <http://web.mit.edu/jsterman/www/SDG/beergame.html>.

19. Sterman, John D. "Learning from Evidence in a Complex World." Web. 02 Nov. 2010. <http://www.ncbi.nlm.nih.gov/pubmed/16449579>.

20. Thomsen, CPT Kim. “Health Promotion and Wellness Staffing Methods.” Web. 02 Nov. 2010. < http://handle.dtic.mil/100.2/ADA420874>

21. Tien, James M., and Pascal J. Goldschmidt-Clermont. "Healthcare: A Complex Service System." *Journal of System Science* 18.3 (2009): 257-82. Web.

22. "Total Force Fitness for the 21st Century." *AMSUS - The Society of the Federal Health Agencies*. Web. 02 Nov. 2010. <http://www.amsus.org/index.php/component/content/article/86-news-article-1/252-total-force-fitness-for-the-21st-century>.

Biography

John Hess is a graduate student at the Massachusetts Institute of Technology where he is pursuing a dual Masters Degree in the Department of Aeronautics and Astronautics and the Technology and Policy Program. He recently left the Air Force Flight Test Center at Edwards AFB, where he was working on Test and Evaluation of Electronic Warfare systems to pursue his graduate studies. His research interests are in the areas of self-organizing systems, complex systems, and technology policy.

Cody Kamin is a graduate student at the Massachusetts Institute of Technology where he is pursuing a Masters Degree in the Technology and Policy Program. He graduated from the Georgia Institute of Technology with a BS in Aerospace Engineering before his matriculation to MIT. His research interests are in the area of policy and systems engineering as they apply to healthcare systems.

C. Robert Kenley holds a Ph.D. and M.S. in Engineering-Economic Systems from Stanford, a M.S. in Statistics from Purdue, and a S.B. in Management from MIT. He has over 30 years experience in aerospace and nuclear systems engineering. He has provided clients with insight and understanding of systems problems as an independent consultant, and he currently is a research associate at MIT. He is a published author of several papers and journal articles in the fields of systems engineering, decision analysis, Bayesian probability networks, and applied meteorology..