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Medical Total Force Management: Assessing Readiness and Cost

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Executive Summary

The military medical force is an essential element of Department of Defense (DoD) warfighting capability, saving life and limb on the battlefield and maintaining the effectiveness of warfighters in the field. Some of these military personnel also support the provision of beneficiary healthcare, working in military treatment facilities (MTFs) to maintain their readiness (clinical proficiency) by providing healthcare to military members, dependents, and retirees.

The medical force is also one of the largest and most costly forces to maintain in DoD. The Under Secretary of Defense for Personnel and Readiness (USD(P&R)), working with the Office of Cost Assessment and Program Evaluation (CAPE), has led a series of studies, finding that the medical force historically under-staffs specialties required for DoD's operational mission (e.g., emergency medicine physicians and surgeons), over-staffs specialties used for beneficiary healthcare (e.g., pediatricians and obstetricians), and, overall, maintains a larger Active Duty medical force than is required. Further, the Military Compensation and Retirement Modernization Commission and a recent National Academies of Science, Engineering, and Medicine report find that the medical force does not have access to the volume of workload needed for training related to its operational mission. These force mix and readiness challenges are a major focus of the Military Health System (MHS) reforms directed in the Fiscal Year (FY) 2017 National Defense Authorization Act (NDAA).

The office of Total Force Manpower and Resources (TFM&RS), within USD(P&R), is responsible for force mix policy and analysis. TFM&RS has led a wide range of studies on force mix issues, including medical total force management. TFM&RS asked the Institute for Defense Analyses (IDA) to evaluate the evidentiary base for military-to-civilian conversion planning and expand analytic methods used for medical total force mix evaluation to include assessment of effectiveness (readiness) as well as efficiency (cost).

Clinical Readiness and Medical Force Mix

DoD historically has not focused on assessing clinical readiness of the medical force. Credentialed medical personnel, e.g., physicians, were considered ready if their credential was current. In addition, medical personnel were widely considered substitutable for one another, e.g., a pediatrician could serve in a position providing emergency care interchangeably with an emergency medicine physician. The wars in Iraq and Afghanistan revealed that assigning the right specialty to a function and ensuring that specialists were clinically proficient in the workload they needed to perform during deployment were essential to reducing preventable death. The Congress has now mandated that DoD maintain the right specialties for operational requirements and focus on the clinical readiness of the force.

The previous major studies of force mix by USD(P&R) and CAPE similarly did not focus on the tradeoff between Active Component (AC) and Reserve Component (RC) performance for meeting requirements—Service-specific AC/RC allocation rules were applied and little further assessment was conducted. This paper focuses on three specific elements of the tradeoff between AC and RC personnel. The first two, accessibility and cost, are well understood—AC forces are generally more accessible (i.e., can be deployed more quickly, more reliably, and more often), while RC forces are generally less expensive to maintain during peacetime.

The third element of the tradeoff is clinical readiness. The recent experiences in the wars and a growing literature document the limited availability of readiness-related workload in the MTFs to support the clinical readiness of AC medical forces. RC forces, on the other hand, may have a higher level of clinical readiness than AC forces (e.g., an RC emergency medicine physician working in a busy civilian emergency department) or lower (e.g., an enlisted medic working in automotive repair for civilian employment). There are also specific examples in which Reserve forces were more advanced and consistent with best practice than Active forces, e.g., the National Guard's use of critical-care trained flight paramedics on medical evacuation helicopters, whereas Active forces were not consistent with best practice and used basic emergency medicine technicians (transitioning late in the wars to the best practice). This paper builds on the growing literature about clinical readiness of the AC force to quantitatively evaluate the tradeoff between AC and a modified RC arrangement with respect to clinical currency.

Given the size and cost of the medical force, these readiness and force mix challenges can have large impacts on DoD cost. Use of expensive military medical personnel for the provision of beneficiary healthcare—if they are not ready for the operational mission—or use in overhead (e.g., staff) positions that do not require their skill level consume significant resources that could be realigned within the defense budget to support readiness and modernization. As previous work by USD(P&R) and CAPE have found, the savings available from improving force mix can be very large.

Assessing Current Force Mix

To assess the readiness level of the current force, two specific elements are examined. First, as with previous analyses, we consider the ability to meet a numeric demand for medical personnel. Second, unlike previous analyses, we consider the clinical readiness of the medical personnel in order to establish deployability of the individual.

Although this paper applies to the total medical force (i.e., all specialties in the AC, RC, civilian, and contractor workforce), our analysis concentrates on physicians who support emergency and surgical care in theater. To establish a demand for providers, the IDA team calculated the deployment of eight specific medical specialties by month from October 2001 through July 2016 in support of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) and estimated how many OIF/OEF-sized conflicts could be executed with available forces using Service deployment policies (most importantly, deployment lengths and dwell times). If all AC and RC forces are assumed to be clinically ready and deployable, the current force could support, on average over all Services and the specialties of focus, 2.22 times the OIF/OEF time series of deployments; i.e., the medical force could indefinitely sustain warfight(s) that total 2.22 times the deployment intensity of OIF/OEF.

To introduce clinical readiness into the assessment, a second estimate is made that only allows as many AC medical personnel to be deployed as can be kept clinically ready by MTF workload. When this clinical readiness requirement is included, the current force among the specialties of focus can support only 0.71 OIF/OEF deployments. This value below 1.0 reflects that DoD, with current capability, would not be able to fully staff a replication of OIF/OEF with providers who were ready (e.g., had clinical experience in the types of cases they would see when deployed). The reduction from a higher apparent capacity to a practical capacity of 0.71 would be reflected in the Defense Readiness Reporting System (DRRS) if clinical readiness were measured by DoD.

This analysis addresses the first request from TFM&RS—evaluate the evidentiary base for military-to-civilian conversion planning. Prior assessment of military-to-civilian conversion opportunities compared a numeric AC requirement to executed end strength. When clinical readiness is included, it identifies a large segment of the AC medical force that is not meeting a deployable requirement (because there is not enough workload to keep them clinically ready). These personnel are being maintained on Active Duty military status for the provision of beneficiary healthcare but are not deployable. Military personnel that are not being maintained in support of a military-essential requirement can be converted without affecting readiness. For the eight physician and dental specialties examined in this paper, the budgetary savings to the federal government from converting these positions would be about $800 million over the Future Years Defense Program (FYDP) period (about $161 million per year). As fixed and future costs adjusted, the full savings to the taxpayer would grow to over $1.1 billion over the FYDP.

These savings are based on only eight specialties of focus, a small fraction of the total medical force. Making these changes would allow for conversion of supporting personnel (e.g., nurses and technicians) and the same analysis could be applied to other physician specialties. Expanding the analysis to these additional positions would likely result in larger estimates of savings, but that was beyond the scope of this project.

Expanding Force Mix Options

With current force mix options, the low level of readiness (0.71 replications of OIF/OEF deployment levels) is difficult to improve. The two current options for increasing readiness are to expand the AC in MTFs and expand the RC. Expanding the AC force in MTFs produces no improvements because the existing force is using all the available readiness-related workload. RC providers maintain their readiness in their civilian occupations and are therefore not limited in that way, so some improvement can be made by expanding the RC. Up to about a doubling of the RC (in the specialties of focus), the number of OIF/OEF deployment levels increases approximately linearly with total force cost. However, RC expansions beyond this level induce diminishing marginal returns. Because only AC providers can deploy with minimal lead time (accessibility), expanding the RC cannot help the force meet immediate unexpected deployment demands; therefore, it is not feasible to meet the 2.22 factor or higher by RC expansion alone. To improve readiness, it will be necessary to expand the set of force mix options available for use with medical forces.

In previous work, IDA assessed three options for expanding AC medical force access to readiness-related workload: (1) investing in MTFs to achieve state trauma center designation and receive civilian patients, (2) establishing joint military-civilian trauma centers by partnering with civilian facilities, and (3) permanently stationing military providers in civilian trauma centers. This previous work identifies specific markets where these opportunities exist, challenges to implementing the options, and ways to overcome these challenges.

This paper considers two options for expanding RC use: (1) redesigning the current RC arrangement to reduce its bureaucratic burden while increasing its requirements for and monitoring of civilian employment that supports readiness, and (2) adding a low-cost, rarely activated strategic Reserve option, sharing features with the Civil Reserve Air Fleet, National Disaster Medical System, and the affiliated Reserve of the First and Second World Wars. Together, these analyses yield four alternative force mix options: (1) AC in MTFs that have been expanded to become DoD-owned or military-civilian partnership trauma centers, (2) AC in civilian trauma centers, (3) redesigned operational RC, and (4) strategic RC.

If DoD adopted these alternative force mix options, it could achieve higher levels of readiness and, for any given level of readiness achievable under the status quo, achieve it at lower cost. In particular, achieving a readiness level of 2.22 OIF/OEFs (which is not feasible with status quo options) would be feasible with the alternative force mix options. In addition, achieving a readiness level of 1.77 OIF/OEFs (which is feasible under the status quo options) would cost about $1.63 billion less over the FYDP ($326 million per year) than achieving it with the status quo options. As with the previous conversion analysis, these estimated savings only take into account changes to eight of the over 100 specialties in military medicine. The savings would be larger if extrapolated to a wider range of specialties.

Conclusions and Recommendations

In summary, IDA found that:

- The medical force currently faces significant readiness challenges and cannot support the scale of operations that the size of the force would suggest;
- Military-to-civilian conversion opportunities are broader than has been previously assessed and can be implemented without reducing readiness when the position targeted for conversion was not providing readiness-related workload and, thus, not maintaining a clinically ready, deployable individual;
- It would be very costly and, at higher levels, infeasible to be ready for larger scale operations with current medical force mix options; and
- Expanding the range of force mix options can achieve a given level of readiness at lower cost.

Based on these findings, IDA developed policy-level and implementation-level recommendations for consideration by TFM&RS. The policy-level recommendations include:

- Measure and report individual (and team) clinical readiness.
- Convert military positions that are not associated with readiness-related workload to civilian performance (or realign facility to eliminate position).
- Expand the readiness-related workload available to AC military personnel.
- Increase use of RC for provision of critical wartime medical specialties.

IDA conducted extensive interviews to identify implementation challenges for these recommendations (see full report for the findings of those interviews and specific implementation recommendations).

The paper concludes with a brief excursion on the military nursing workforce. While most of this paper has been focused on the challenges of maintaining a clinically ready medical force, other challenges with the medical force involve force mix decisions. One of these is that the medical force is primarily focused on highly technical skilled tasks (e.g., trauma surgery and skilled nursing care) and not strategic combat leadership, while the military force management system (e.g., little lateral entry and required up-or-out career paths) is focused on growing leaders for progressively larger roles in combat leadership. The military nursing force is an excellent example of this challenge. Civilian best practice typically involves nurses working in a clinical setting most or all of their careers. Current DoD force management policies, however, make this impossible because an individual’s ability to stay in military service is tied to length of service, rank, and promotions. This creates a situation where nurses must leave clinical practice, and progressively expanding leadership positions must be created for Nurse Corps officers to maintain promotion pathways. The concern is that these created positions do not fully employ the clinical education and training nurses possess. The IDA team found suggestive evidence to support this concern, but was not able to quantitatively estimate its cost within the scope of the excursion with the data IDA had obtained for this analysis. The paper documents the additional data that would be required and how a complete estimate could be made.

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1. Introduction

The military medical force is an essential element of Department of Defense (DoD) warfighting capability, saving life and limb on the battlefield and maintaining the effectiveness of warfighters in the field. The medical force also supports the provision of beneficiary healthcare, working in military treatment facilities (MTFs) to maintain their readiness (clinical proficiency) by providing healthcare to military members, dependents, and retirees. Approximately one-third of beneficiary healthcare is provided in MTFs to support this readiness function, while the remainder is purchased from the private sector.

The medical force is also one of the largest and most costly forces to maintain in DoD. The Under Secretary of Defense for Personnel and Readiness (USD(P&R)), working with the office of Cost Assessment and Program Evaluation (CAPE), has led a series of studies (summarized in Chapter 3) finding medical force challenges driving costs higher than necessary. USD(P&R) has found that the medical force historically under-staffs specialties required for DoD's operational mission (e.g., emergency medicine physicians and surgeons) and over-staffs specialties used for beneficiary healthcare (e.g., pediatrics and obstetrics). In addition, excess Active Duty forces (i.e., not required for operational mission) have historically been maintained for the provision of beneficiary healthcare in MTFs when civilian personnel would be more efficient. The Military Compensation and Retirement Modernization Commission (MCRMC) also highlighted readiness challenges in its report to the Congress, finding that the medical force is not able to train on workload relevant to its deployed mission. These force mix challenges are particularly important given the major reforms of the Military Health System (MHS) directed in the Fiscal Year (FY) 2017 National Defense Authorization Act (NDAA).

The Office of Total Force Manpower and Resources (TFM&RS), within USD(P&R), is responsible for force mix policy and analysis. TFM&RS has led a wide range of studies on force mix issues, including medical total force management. Historic analysis of medical force mix has focused on estimating the level of Active Component (AC) force requirements and make-buy assessment (military-to-civilian conversion) for AC staffing above the readiness requirement. TFM&RS asked the Institute for Defense Analyses (IDA) to expand this historic analysis by looking at readiness more broadly and incorporating Reserve Component (RC) forces. Specifically, TFM&RS asked IDA to:

- Improve the evidentiary base for military-to-civilian conversion planning,

- Expand analytic methods used for medical total force mix evaluation to include assessment of effectiveness (readiness) as well as efficiency (cost), and
- Identify specific force mix improvements that could enhance readiness and reduce costs.

These are enduring challenges with medical force mix analysis and policy, but are particularly important to address now in the context of the FY 2017 NDAA reforms.

The scope of this paper includes the total medical force (i.e., all specialties in the AC, RC, civilian, and contractor workforce), but most of the analysis is focused on physicians who support emergency and surgical care in theater. The focus is on emergency and surgical care because these high-skill medical tasks are a primary consideration in readiness and a primary driver of theater medical support. Further, readiness benchmarks developed specifically for these occupations using theater inpatient data are available. Because inpatient platforms are a major organizational and cost factor for the MTF system, we focus on them in this paper. This focus is consistent with current DoD analytic efforts (e.g., the NDAA focus on inpatient platforms and the recently completed CAPE-directed study of medical readiness within inpatient platforms). Many of the critical tasks for saving life and limb occur prior to hospitalization, making pre-hospital care an important area for further force mix analysis. Routine care is also delivered in theater and is another important area for further analysis.

Chapter 2 provides a brief introduction to the medical force. Chapter 3 provides a more detailed examination of medical force challenges, particularly with respect to readiness. Chapter 4 specifically addresses the challenges of measuring medical readiness and incorporating it into force mix assessment. Chapter 5 provides a quantitative assessment of the current level of readiness being achieved. Chapter 6 discusses how introducing alternative force mix options can improve readiness. Chapter 7 analyzes the potential for decreasing cost and/or increasing readiness with current and alternative force mix options. Chapter 8 draws conclusions based on the analysis in the previous chapters and recommends actions DoD could take to make these force mix options available for use.

Chapter 9 provides a discussion on a related force mix challenge by studying the nurse force. One particular challenge with force mix analysis is identifying the appropriate conversion rate for a particular realignment, e.g., military-to-civilian conversions. Many members of the medical force serve in tours of duty that do not involve the provision of clinical care. Nurses provide a good example—many nurses leave clinical care relatively early in their military career and serve in leadership and staff roles thereafter. Using nursing as a case study, Chapter 9 examines the force mix implications of this career path.

2. Medical Force Overview

The medical community contains all the elements of total force mix: a large number of AC and RC military personnel, civilians, and contractors.[1] This chapter provides a brief overview of the medical force, estimated costs of selected medical occupations (with a more detailed explanation of the cost estimation in Appendix B), and a review of the deployment experience of the medical force during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF).

A. Medical Force Personnel and Mix

The military medical force contains approximately 200,000 personnel. When combined with the civilian medical workforce, the total force exceeds 240,000 personnel (along with a large number of contractors). Table 1 provides a breakout of the medical force by Service and performer type. The Army has the most evenly spread force (over AC, RC, and civilians) while the Navy has the most concentrated force in AC personnel.

Table 1. Medical Force Size, September 30, 2015

Service/DoD	AC	RC	Civilian	Total
Army	50,612	50,411	27,644	128,667
Navy	36,533	12,370	6,760	55,663
Air Force	30,300	19,601	3,858	53,759
DoD	N/A	N/A	3,287	3,287
Total	117,445	82,382	41,549	241,376

Source: Health Manpower Personnel Data System Fiscal Year Statistics 2015, published by Defense Manpower Data Center (DMDC) and Defense Health Agency.

The requirement for military medical personnel is driven by the operational mission—providing a deployable force to treat casualties and maintain the fighting force in the field. For many of these personnel, their day-to-day activity in peacetime is to work alongside civilians and contractors in the provision of beneficiary healthcare at military hospitals. Another set of military personnel are assigned to their line (non-medical) units during peacetime and engage in ongoing training for the operational mission like most other Service members (these personnel are often called “organic” medical support to the

[1] Appendix A provides a description of the data sources used for this report.

line units). A third set of military personnel are assigned to a wide range of staff and other supporting positions during peacetime, where they engage in little to no healthcare delivery (perhaps visiting a clinic one or two afternoons a week). Given the high cost of military medical personnel (discussed in more detail in the next section), the number and type of medical personnel in these "overhead" positions has been a long-running concern for many.

The military medical force contains enlisted personnel (medical and dental) and officers (physicians, dentists, nurses, and medical service officers). Table 2 provides a breakdown of these categories. It is notable that 32.6 percent of medical personnel are officers, well above the DoD-wide officer share of 20.8 percent (19.1 percent if warrant officers are excluded).

Table 2. Counts of Medical Personnel by Corps and Component, July 31, 2016

Occupational Group	Army		Navy		Air Force		Total
	AC	RC	AC	RC	AC	RC	
Enlisted	33,234	34,621	25,000	8,783	19,126	12,400	133,164
Physician	4,517	1,997	3,875	1,033	3,542	1,585	16,549
Dentist	1,163	954	1,146	1,263	986	479	5,991
Nurse	3,741	4,598	3,066	1,750	3,225	2,710	19,090
Other*	6,988	7,126	2,709	612	3,308	2,050	22,793
Total	49,643	49,296	35,796	13,441	30,187	19,224	197,587
AC/RC Shares of Service Total	50.2%	49.8%	72.7%	27.3%	61.1%	38.9%	

Source: DMDC personnel files.

*Includes Veterinarians, Medical Services, Army Medical Specialists, Biomedical Sciences, and Health Services Administration.

Much of the analysis in this paper is focused on physicians in core readiness-related surgical specialties, emergency medicine, and anesthesiology.[2] Table 3 provides the end strength for these specialties. While we include Critical Care/Trauma–Medicine and Critical Care Trauma–Surgery in Table 3, we do not use these occupations in the later analysis because these occupations only exist in our data from 2009 onward and are especially rare. In total, the specialists examined constitute 2.1 percent of the military medical force and 6.6 percent of medical officers. AC personnel constitute 62 percent of these specialists in the Army and 74 percent each in the Navy and Air Force. Overall, 68.5 percent of these specialists are in the AC, compared to 58.5 percent of the military medical force.

[2] Oral maxillofacial surgeons are included in the dental corps.

Table 3. Counts of Medical Personnel by Specialty and Component, July 2016

	Army		Navy		Air Force		
Specialty	**AC**	**RC**	**AC**	**RC**	**AC**	**RC**	**Total**
Anesthesiology	148	95	121	51	189	75	679
Cardiac/Thoracic Surgery	14	16	9	6	10	6	61
Critical Care/Trauma, Medicine	4	26	10	1	3	2	46
Critical Care/Trauma, Surgery	25	8	0	0	0	0	33
Emergency Medicine	349	276	207	76	224	90	1,222
General Surgery	301	208	188	48	166	71	982
Neurological Surgery	28	22	11	5	25	16	107
Oral Maxillofacial Surgery	106	18	55	12	108	22	321
Orthopedic Surgery	258	83	106	42	170	46	705
Peripheral Vascular Surgery	24	6	17	2	14	1	64
Total	1,257	758	899	314	734	258	4,220
Share of Service Total	62.4%	37.6%	74.1%	25.9%	74.0%	26.0%	

B. Medical Force Cost

In addition to being one of the largest elements of the military force, medical personnel are some of the most expensive personnel employed by DoD. USD(P&R) and CAPE have conducted extensive analysis on the total cost of the medical force and the impact on force management of having visibility into only part of the total cost.[3] This paper draws on this previous cost work for the estimates used in the analysis.

This paper uses two estimates of cost. In the development of optimal force mix allocations and the estimation of full, long-run savings from reform options, the total cost to the taxpayer of medical personnel is used. This cost includes:

- Immediate costs borne by DoD such as pay, benefits, training, etc.;
- Fixed costs paid by DoD that will not adjust immediately in response to a change in force levels, but will respond over time (e.g., child care centers and commissaries);
- Deferred costs that will ultimately be borne by DoD (e.g., the non-Medicare eligible retiree healthcare benefit); and

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[3] For a review of this analysis, see John E. Whitley et al., "Medical Total Force Management," IDA Paper P-5047 (Alexandria, VA: Institute for Defense Analyses, May 2014).

- Costs borne by other federal agencies (e.g., benefits paid by the Veterans Administration).

Although total cost is the most relevant estimate of cost for decision making, it does not provide an estimate of the near-term budgetary savings that would occur from implementing a reform. Realization of total cost occurs beyond the Future Years Defense Program (FYDP) period. The second estimate of cost used is the first element of total cost—immediate costs borne by DoD. This represents a cash flow view of changes, i.e., the budgetary savings that would result the year (or year after) a reform was implemented. This is the estimate that would be used for savings in the FYDP.

Appendix B describes the data sources and methods used to compute the full and cash flow cost estimates. Table 4, Table 5, and Table 6 present these estimates by Service for non-deployed (and non-activated in the case of the RC) personnel in the occupations of focus in this paper. Roughly 60 percent of RC costs, 88 percent of AC costs, and 92 percent of civilian costs are cash flow costs to DoD. RC total costs range from 13.4 percent to 19.0 percent and civilian total costs range from 67.7 percent to 104.5 percent of the respective AC total costs.

Table 4. Army Costs by Occupation and Personnel Type, in Thousands of 2017 Dollars per Person-Year

	Total Cost			DoD Cash Flow Cost		
Occupation	**AC**	**RC**	**Civilian**	**AC**	**RC**	**Civilian**
Anesthesiology	513	84	413	455	52	380
Cardiac/Thoracic Surgery	591	83	509	526	51	468
Emergency Medicine	455	83	320	397	52	295
General Surgery	511	84	412	452	52	379
Neurological Surgery	570	82	510	513	50	469
Oral Maxillofacial Surgery	506	80	373	446	48	343
Orthopedic Surgery	589	83	514	530	51	473
Peripheral Vascular Surgery	607	85	411	543	53	378

Table 5. Navy Costs by Occupation and Personnel Type, in Thousands of 2017 Dollars per Person-Year

	Total Cost			DoD Cash Flow Cost		
Occupation	**AC**	**RC**	**Civilian**	**AC**	**RC**	**Civilian**
Anesthesiology	515	86	415	453	53	383
Cardiac/Thoracic Surgery	556	85	513	490	52	473
Emergency Medicine	449	85	322	388	52	297
General Surgery	503	86	414	442	53	382
Neurological Surgery	542	84	514	480	51	473
Oral Maxillofacial Surgery	503	83	375	442	50	346
Orthopedic Surgery	549	85	517	489	52	476
Peripheral Vascular Surgery	579	87	414	516	54	381

Table 6. Air Force Costs by Occupation and Personnel Type, in Thousands of 2017 Dollars per Person-Year

	Total Cost			DoD Cash Flow Cost		
Occupation	**AC**	**RC**	**Civilian**	**AC**	**RC**	**Civilian**
Anesthesiology	456	77	407	399	44	374
Cardiac/Thoracic Surgery	481	79	503	424	45	462
Emergency Medicine	407	76	315	350	43	290
General Surgery	453	77	406	396	44	373
Neurological Surgery	500	77	503	439	44	462
Oral Maxillofacial Surgery	512	79	368	439	45	338
Orthopedic Surgery	499	77	506	464	44	465
Peripheral Vascular Surgery	506	79	405	446	46	372

As can be seen, the costs across Services are similar but do diverge somewhat. Reasons for this divergence include many factors, e.g., different rates at which various bonuses are used and different retention lengths for providers (which change the annualized cost of training). By multiplying the costs in Table 4, Table 5, and Table 6 with the July 2016 counts in Table 3, we can calculate the annual costs of all uniformed personnel in the listed occupations, except for costs associated with deployment. For the eight occupations of focus in this paper, this "peacetime cost" is $1.515 billion per year.

The high cost of these personnel emphasizes the importance of maintaining their focus on the operational mission and ensuring they are ready (clinically current). Use of more costly personnel for beneficiary healthcare (when not maintaining readiness for the operational mission) or overhead (e.g., staff) functions when their skills are not essential for that function wastes taxpayer resources that could be applied more effectively elsewhere to provide readiness capability. Comparing the cost of AC with civilian personnel also reveals the inefficiency of using military personnel when a civilian can meet the need. These cost issues are a major focus of the analysis in this report.

C. Medical Force Deployment Experience

The medical force is an essential element of DoD's warfighting capability. The operational mission of the medical force is to save life and limb on the battlefield while maintaining the health (effectiveness) of warfighters in the field. The occupations of focus in this paper are specialists central to the delivery of combat casualty care (CCC). CCC ranges from immediate care at the point of injury through evacuation from theater to a fully equipped hospital.

DoD developed and implemented the Joint Theater Trauma System (JTTS) during OEF and OIF, which reduced mortality rates compared to previous conflicts.[4] The JTTS is organized into roles, numbered 1 through 4, with a larger number generally representing increased medical capability and distance from the point of injury.[5] Role 1 refers to point of injury care with no or minimal surgical capability. Role 2 refers to resuscitative and damage control care and, as "2+", includes life-saving surgery capability. Role 3 refers to in-theater MTFs with robust capability. Role 4 refers to out-of-theater MTFs staffed for all surgical specialties. Patients who are too severely injured to return to duty are transferred to a higher-role facility. The specialists considered in this analysis generally deploy to Role 2, 3, and 4 facilities.

Table 7 shows the magnitude of deployments for the occupations of focus in this paper, separated by Component. From October 2001 to July 2016, personnel in these occupations deployed for a total of about 1.05 million person-days, 78.4 percent of which were served by AC personnel. Figure 1 illustrates trends in AC and RC deployments over this period for the occupations of focus. AC deployments peaked in May 2003, two months after the beginning of OIF, then fell to roughly one-third as many within a year. RC deployments rose significantly through July 2003, then decreased gradually over the next two years. The surge in RC deployments at the beginning of OIF lagged the surge in AC deployments by approximately one month.

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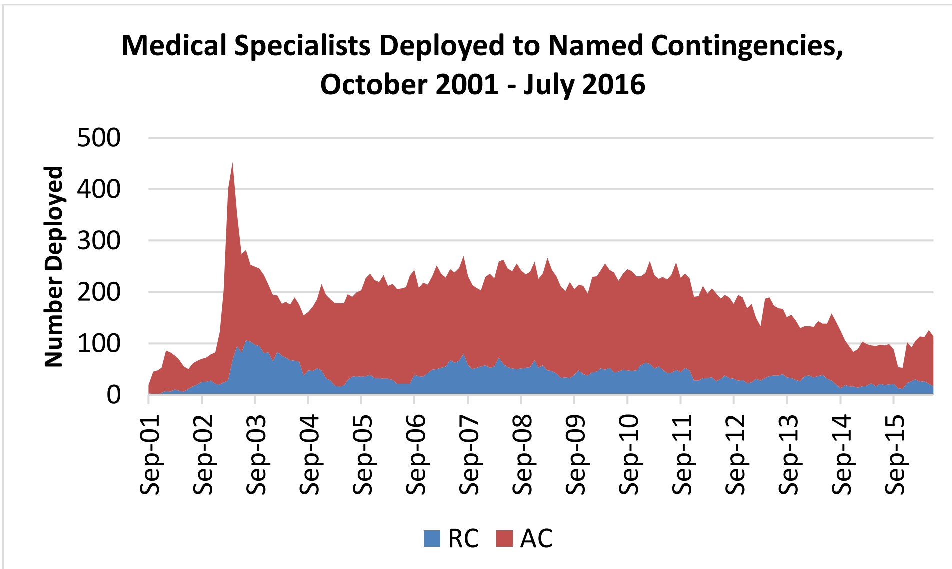
4 Brian J. Eastridge et al., "Trauma System Development in a Theater of War: Experiences from Operation Iraqi Freedom and Operation Enduring Freedom," *Journal of Trauma and Acute Care Surgery* 61, no. 6 (June 2006): 1366–73, doi: 10.1097/01.ta.0000245894.78941.90; and Matthew S. Goldberg, "Casualty Rates of US Military Personnel during the Wars in Iraq and Afghanistan," *Defence and Peace Economics* (2016): 1–21, doi: 10.1080/10242694.2015.1129816.

5 Miguel A. Cubano, Martha K. Lenhart, U. S. Army, and Office of the Surgeon General, *Emergency War Surgery*, 4th ed. (Fort Sam Houston, TX: Borden Institute, 2013). Some sources also recognize a fifth role, wherein contiguous United States (CONUS) hospitals provide definitive care and rehabilitation to the most severely injured patients.

Table 7. Medical Specialist Days (1,000s) Deployed by Component, Oct 2001–Jul 2016

Occupation	AC	RC	Share AC
Anesthesiology	120.4	21.5	84.9%
Cardiac/Thoracic Surgery	18.9	6.5	74.3%
Emergency Medicine	248.9	66.3	79.0%
General Surgery	255.2	87.9	74.4%
Neurological Surgery	12.1	2.7	81.9%
Oral Maxillofacial Surgery	24.0	5.1	82.5%
Orthopedic Surgery	134.3	34.8	79.4%
Peripheral Vascular Surgery	12.6	3.2	79.7%
Total	**826.3**	**228.1**	**78.4%**



Source: DMDC personnel files and Contingency Tracking System (CTS) data.

Note: AC and RC deployments are stacked; the height of the top curve represents total deployments.

Figure 1. Monthly Counts of Deployed Medical Specialists, October 2001–July 2016

Medical officers deploy infrequently compared to the rest of the military force. The medical force's large size, combined with changes to warfighting (leading to fewer casualties) and healthcare delivery (greater focus on more rapid lifesaving and quicker evacuation), made it the lowest-deploying element of the force in OIF/OEF. Figure 2 illustrates this fact by comparing deployment rates over the timeframe of this project across occupational areas, with the healthcare officer occupational area further divided into occupational groups.[6] Each of these six occupational groups (dentists, nurses,

[6] An occupational area is identified by the first two digits of a DoD occupation code. For an officer, an occupational group is identified by the first four digits of a DoD occupation code.

physicians, biomedical sciences and allied health officers, health services administration officers, and veterinarians) were deployed less often than every other occupational area. Among enlisted occupation areas, healthcare specialists were the least often deployed.

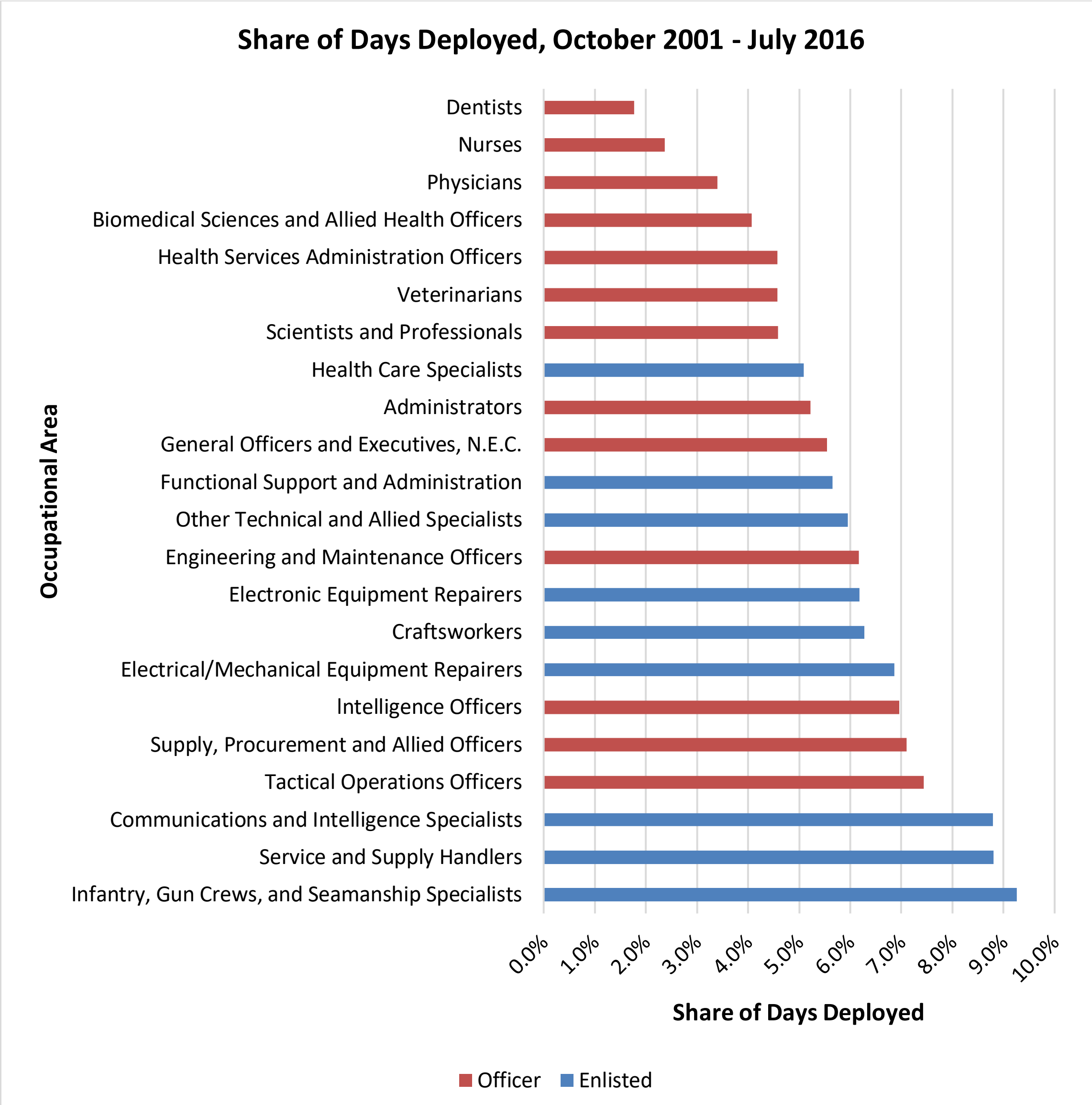


Figure 2. Deployment Rates by Occupational Area/Group, October 2001–July 2016

Table 8 lists the share of time spent deployed for each of our eight selected occupations, critical care/trauma physicians, and all other medical officers as a whole from October 2001 through July 2016.[7] The data come from the DMDC CTS and include

[7] Because the personnel data with which we merged the deployment data is at the month level, we generally could not exactly identify the number of days served by an individual in their first and after their last observed month. We imputed half the duration of each first and next-after-last observed month as a best estimate of the number of days served in each such month.

only deployments to named contingencies, primarily OIF and OEF over the period studied. Two of our occupations of focus deployed more often than the average medical officer. Critical care/trauma surgeons had the highest deployment rate, followed by emergency medicine physicians, peripheral vascular surgeons, general surgeons, and cardiac/thoracic surgeons.

Table 8. Medical Specialist Deployment Rates, October 2001–July 2016

Occupation	Days Deployed (Thousands)	Days Served (Thousands)	Share of Days Deployed
Critical Care/Trauma, Surgery	6	93	5.99%
Emergency Medicine	315	5,983	5.27%
Other Medical Officer	53,349	1,022,140	5.22%
Peripheral Vascular Surgery	16	304	5.21%
General Surgery	343	6,654	5.16%
Cardiac/Thoracic Surgery	25	540	4.70%
Orthopedic Surgery	169	4,470	3.79%
Anesthesiology	142	4,243	3.34%
Critical Care/Trauma, Medicine	6	220	2.57%
Neurological Surgery	15	691	2.14%
Oral Maxillofacial Surgery	29	1,974	1.48%

3. Medical Force Challenges

In addition to being costly, the medical force also suffers from well-documented force challenges. This chapter summarizes the challenges focused on in this paper.

A. Past Requirements and Force Mix Studies

Multiple comprehensive studies have identified medical force challenges we address in this paper. In April 1994, USD(P&R) and CAPE completed the co-led “733 Study” as directed by Section 733 of the National Defense Authorization Act (NDAA) for Fiscal Years (FY) 1992 and 1993 (Pub. Law 102-190, December 5, 1991).[8] The 733 Study modeled casualties arising from operations consistent with US military strategy and determined the number of physicians required to support those operations. The study found that the physician force projected for FY 1999 could be reduced by 24 percent. In 1999, DoD published an update to the 733 Study that placed greater emphasis on training and maintaining physicians.[9] The 733 Study update found that the physician force could decrease by 28 percent and still meet all requirements.

DoD published the Medical Readiness Review (MRR) in 2008.[10] The MRR modeled casualties in the context of new systems for delivering CCC and new projected warfighting scenarios. Through a comprehensive evaluation of requirements for each medical occupation, the MRR found that about 20 percent of medical end strength was not military essential. The MRR also highlighted the misalignment between executed end strength and identified requirements. An illustrative example taken near the start of the wars in Iraq and Afghanistan highlighted in the MRR report is recreated in Table 9.

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8 Department of Defense (DoD) Office of Program Analysis and Evaluation, “The Economics of Sizing the Military Medical Establishment: Executive Report of the Comprehensive Study of the Military Medical Care System” (Washington, DC: Department of Defense, April 1994).

9 DoD Office of Program Analysis and Evaluation, “Section 733 Update: Report of the Working Group on Sustainment and Training” (Washington, DC: Department of Defense, April 1999).

10 DoD, “Final Report: DoD Force Health Protection and Readiness—A Summary of the Medical Readiness Review, 2004–2007,” June 2008.

Table 9. FY 2004 Specialty Mix Imbalance

	Readiness Requirement	FY 2004 Executed End Strength	End Strength Minus Requirement
Pediatrics	286	645	359
Obstetrics	208	387	179
Anesthesiology	318	259	−59
General Surgery	685	443	−242

Source: "Final Report: DoD Force Health Protection and Readiness—A Summary of the Medical Readiness Review, 2004–2007," June 2008.

Note: The FY 2004 requirement is for fully trained providers. The total requirements, including training, transients, prisoners, etc., were Pediatrics, 484; Obstetrics, 351; Anesthesiology, 444; and General Surgery, 947.

Whitley et al. (2014) examined the nature, causes, and potential solutions to inefficiencies in medical force mix.[11] In particular, it found that a large portion of Service requirements for medical personnel is not operationally relevant, and that military-to-civilian conversion could bring significant savings to DoD. The paper also recommended that DoD reconsider the balance of AC and RC medical personnel.

In summary, these analyses focused on specific questions that include:

- How many AC military medical personnel are required for operational missions?
- If the AC medical force is larger than this requirement, would it be economical to convert the non-required military personnel (most of whom are working in MTFs delivering beneficiary healthcare) to civilians?

In other words, these papers were economic make-buy analyses on above readiness end strength. Their primary readiness consideration was whether or not a numeric requirement for military personnel was met. These papers contained little assessment of the clinical readiness of individual medical personnel or the optimal allocation of operational requirements across AC or RC performance.

B. Clinical Readiness Studies

DoD historically has not focused on assessing clinical readiness of the medical force. Credentialed medical personnel—e.g., physicians—were considered ready if their credential was current, and medical personnel were widely considered substitutable for one another; e.g., a pediatrician could serve in a position providing emergency care interchangeably with an emergency medicine physician. The wars in Iraq and Afghanistan revealed that assigning the right specialty to a function and ensuring that

11 Whitley et al., "Medical Total Force Management."

specialists were clinically proficient in the workload they performed during their deployment were essential to reducing preventable death. One of the key reports highlighting the importance of this issue was the 2015 MCRMC report. The MCRMC analyzed the differences in the types of care delivered in MTFs as opposed to deployed settings and found a misalignment in both provider specialties and case mix.[12] Among its many recommendations, the MCRMC report recommended that DoD (1) improve its ability to measure medical readiness based on a correspondence between provider workload and the expected categories of workload in theater, and (2) adopt new tools to capture more readiness-relevant workload, especially by treating civilian patients.

The DoD-conducted MHS Modernization Study, studies from CNA and IDA, and a growing academic literature build on and complement the findings and recommendations of the MCRMC report. The MHS Modernization Study, published in 2015, compared workloads by occupation in the MHS to the median civilian workloads reported by the Medical Group Management Association (MGMA).[13] The study measured workload by provider aggregate relative value units (RVUs), which are intensity-weighted measures of clinical services defined by the Centers for Medicare and Medicaid Services. A separate study team established “productivity floors”—RVU targets for clinical currency as a percentage of the MGMA medians. As shown in Table 10, although the productivity floors were roughly 75 percent of the MGMA medians, even MTFs in the 90th percentile of productivity did not meet the productivity floors for Emergency Medicine, General Surgery, and Orthopedic Surgery.

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[12] Alphonso Maldon, Jr. et al., “Report of the Military Compensation and Retirement Modernization Commission,” January 2015.

[13] DoD, “Report on Military Health System Modernization: Response to Section 713 of the Carl Levin and Howard P. ‘Buck’ McKeon National Defense Authorization Act for Fiscal Year 2015,” May 2015.

Table 10. MTF Average RVUs as a Percentage of MGMA Median

	Emergency Medicine	General Surgery	Orthopedic Surgery
Mean	42%	29%	31%
10th Percentile	26%	20%	26%
25th Percentile	31%	24%	27%
50th Percentile	48%	31%	33%
75th Percentile	56%	37%	38%
90th Percentile	66%	43%	41%
Productivity Floor	73.9%	73.9%	72.3%

Source: DoD, "Report on Military Health System Modernization: Response to Section 713 of the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015," May 2015. Includes all MHS markets with at least 1,500 RVUs in FY 2012 for emergency medicine, general surgery, and orthopedic surgery, or at least 10,000 RVUs for family medicine.

Multiple other recent studies have found evidence that readiness-relevant workload in the MHS is low. Brevig et al. (2014) found that MTFs have low workload volume at both the facility and individual provider levels compared to civilian workload and workload standards.[14] Mandell et al. (2016) developed metrics for the clinical proficiency of emergency medicine physicians and found that "emergency medicine physicians in Navy Medicine do not meet the requirements for the numbers and types of cases required to maintain proficiency."[15] Whitley et al. (2016), in follow on support to the MCRMC, found that the categories of inpatient care commonly delivered in MTFs arise uncommonly in theater, and vice versa.[16] Eastridge et al. (2011) found that 51.4 percent of cases in which a patient died of wounds after reaching a theater hospital between October 2001 and June 2009 were potentially survivable.[17]

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[14] Holly Brevig et al., "The Quality-Volume Relationship: Comparing Civilian and MHS Practice" (Alexandria, VA: CNA, November 2014), https://www.cna.org/CNA_files/PDF/DIM-2014-U-009221-Final.pdf.

[15] Kara Mandell et al., "Measuring and Improving Currency in the Navy Emergency Medicine Enterprise" (Alexandria, VA: CNA, September 2016).

[16] John E. Whitley et al., "Essential Medical Capabilities and Medical Readiness," IDA Paper NS P-5305 (Alexandria, VA: Institute for Defense Analyses, July 2016).

[17] Brian J. Eastridge et al., "Died of Wounds on the Battlefield: Causation and Implications for Improving Combat Casualty Care," *The Journal of Trauma, Injury, Infection, and Critical Care* 71, no. 1 (July 2011): S4–8, doi: 10.1097/TA.0b013e318221147b. In a companion study, Eastridge found that about 25 percent of prehospital deaths were due to potentially survivable injuries. Brian J. Eastridge et al., "Death on the Battlefield (2001-2011): Implications for the Future of Combat Casualty Care," *Journal of Trauma and Acute Care Surgery* 73, no. 6 supp 5 (December 2012): S431–7, doi: 10.1097/TA.0b013e3182755dcc.

Academic publications have found that specialization in critical care and trauma significantly decreases mortality in both civilian and military settings. MacKenzie et al. (2006) found that patients with similar demographic and injury characteristics were 25 percent more likely to die while being treated in a non-trauma center as opposed to a Level 1 trauma center, and 33 percent more likely to die within one year of the injury.[18] Lettieri, Shah, and Greenburg (2009) found that an Army Combat Support Hospital in Afghanistan had 39 percent reduced mortality after creating a dedicated team of providers trained and certified in critical care and led by a physician trained in critical care.[19] Gerhardt et al. (2009) found that a battalion aid station staffed by an emergency medicine physician and emergency medicine physician assistant (whereas over 85 percent of battalion aid stations were staffed with a primary care physician and generalist physician assistant) had less than two-thirds the overall theater case fatality rate, despite having over three times the battle casualty rate and the same mean injury severity.[20] Mabry et al. (2012) found that casualties in Afghanistan were three times as likely to die in the first 48 hours following severe injury when transported by the standard Army MEDEVAC system with basic emergency medical technicians than by a system staffed by critical care-trained flight paramedics (as is the civilian standard).[21]

Lurie et al. (2017) built on the MCRMC recommendations by examining individual MTF healthcare markets.[22] This IDA paper established workload benchmarks for physician occupations based on provider workload at San Antonio Military Medical Center (SAMMC). By comparing these benchmarks to all CONUS MTF workload, the authors estimated the number of providers whose readiness can be supported by MTF workload. The paper also explored the possibilities of investing in MTFs and seeking civilian designation as trauma centers, of establishing joint DoD-civilian medical facilities, and of stationing personnel in civilian facilities. The paper found that current MTF workload could only support the readiness of 14 to 28 percent of AC physicians in the occupations considered, and that adopting new tools to capture additional workload could increase that share to up to 46 percent.

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18 Ellen J. MacKenzie et al., "A National Evaluation of the Effect of Trauma-Center Care on Mortality," *New England Journal of Medicine* 354, no. 4 (January 2006): 366–78, doi: 10.1056/NEJMsa052049.

19 Christopher J. Lettieri, Anita A. Shah, and David L. Greenburg, "An Intensivist-Directed Intensive Care Unit Improves Clinical Outcomes in a Combat Zone," *Critical Care Medicine* 37, no. 4 (April 2009): 1256–60, doi: 10.1097/CCM.0b013e31819c167f.

20 Robert T. Gerhardt et al., "Out-of-Hospital Combat Casualty Care in the Current War in Iraq," *Annals of Emergency Medicine* 53, no. 2 (February 2009): 169–74, doi: 10.1016/j.annemergmed.2008.04.013.

21 Robert L. Mabry et al., "Impact of Critical Care-Trained Flight Paramedics on Casualty Survival during Helicopter Evacuation in the Current War in Afghanistan," *Journal of Trauma and Acute Care Surgery* 73, no. 2 supp. 1 (August 2012): S32–7, doi: 10.1097/TA.0b013e3182606001.

22 Philip M. Lurie et al., "Medical Readiness within Inpatient Platforms," IDA Paper NS P-8464 (Alexandria, VA: Institute for Defense Analyses, August 2017).

4. Incorporating Readiness into Force Mix Assessment

Previous assessments of medical force mix, in considering the potential for converting military billets to civilian, defined the convertible set to be those billets in excess of Service requirements for military personnel. These studies used Service requirements as lower bounds on the number of personnel that must be kept ready to deploy, and assumed that the required personnel could be kept ready. For those billets that could be military or civilian, the appropriate personnel type was determined by whichever type represented the least cost. Conversely, this paper uses MTF workload to construct *upper* bounds on the number of personnel that *can* be kept ready, directly models the operational contribution of those ready personnel, and optimizes the mix of personnel options over the entire force.

Previous analyses focused on comparisons of AC and civilian personnel. Consideration of RC personnel as a distinct personnel type is complicated by two primary issues that have prevented previous analyses from considering RC personnel in force mix assessments. First, AC and RC personnel contribute differently to the operational mission. Most importantly, RC personnel cannot deploy as quickly or as often as AC personnel. Second, a non-activated RC person-year generally costs less than an AC person-year. Information sources that other analyses have used to estimate the costs of AC and civilian personnel (e.g., the CAPE Total Cost of Manpower tool) are not available for RC personnel. This paper addresses both of these issues and builds a framework for assessing force mix over any specified set of personnel types. Further, this paper presents another difference between AC and RC personnel—the readiness of the AC is limited by MTF workload. Thus, this paper incorporates readiness in addition to cost into force mix assessment.

A. Measuring Medical Readiness

Unlike other communities in DoD, the medical force historically has not formally tracked individual skill readiness for healthcare providers in deployment decisions. While other communities typically have to demonstrate through training and exercises the possession of skills in key mission essential tasks (METs) in order to be deployable, medical providers were generally assumed to be deployable from a MET perspective if they were currently licensed. Informally, deployment planners, medical specialty leaders, and others worked together to ensure that deploying providers were as prepared as possible—but formal readiness reporting on provider skills is only just now being developed and still does not contain a quantitative assessment of proficiency in deployment-related healthcare.

Medical readiness, which we define as the ability to proficiently deliver care in a deployed setting, has not been consistently measured in DoD. The MCRMC report found that the Services had neither "a common definition of clinical medical readiness, nor associated skills maintenance standards."[23] The MCRMC recommended that DoD identify essential medical capabilities (EMCs) "that must be retained within the military for national security purposes…[and] are vital to effective and timely health care during contingency operations."[24]

Whitley et al. (2016) addressed how EMCs should be developed, defined, and integrated into readiness reporting.[25] The paper found that medical readiness reporting through the Defense Readiness Reporting System (DRRS) was unstandardized, rarely justified by quantitative data, and unable to inform unit readiness with respect to the availability of medical specialties. The paper also found that the closest civilian analogue to medical readiness is clinical currency, of which procedure volume is a relevant and accessible measure. The paper recommended that EMCs inform DRRS reporting, and that these EMCs be based on in-theater medical procedure data.

Medical readiness measurement is a special challenge for RC physicians, who generally maintain their clinical currency in facilities outside DoD. Therefore, we are unable to compare workload volume across Active and Reserve personnel. However, the results from the MHS Modernization Study displayed in Table 10 indicate that workload volume is higher for RC physicians. Assuming that the MGMA medians are representative of RC physicians, it is unlikely that RC physicians working in civilian facilities are less clinically current than AC physicians working in MTFs.

Some RC medical personnel, especially those in the most specialized occupations, are required to be active in a corresponding civilian occupation as a condition of RC employment. Deployable RC surgeons in the Army "must possess a current unrestricted license to practice medicine in a US state, have completed general surgical residency approved by the American Board of Surgery, and must be actively employed in a civilian practice."[26] In the Air Force, "all deploying surgeons must have a robust practice at their

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23 Maldon, Jr. et al., "Report of the Military Compensation and Retirement Modernization Commission."

24 Ibid.

25 Whitley et al., "Essential Medical Capabilities."

26 Joseph DuBose et al., "Preparing the Surgeon for War: Present Practices of US, UK, and Canadian Militaries and Future Directions for the US Military," *Journal of Trauma and Acute Care Surgery* 73, no. 6 supp 5 (December 2012): S423–30, doi: 10.1097/TA.0b013e3182754636.

primary duty stations… defined as 240 cases per year, with 30% of those consisting of adequate currency cases for trauma application as defined by the [Air Force] General Surgery Consultant-required Current Procedural Terminology codes."[27]

B. Complementarity of Beneficiary and Operational Missions

The concept of dual missions for the medical force—maintaining the health of the force in deployed settings and the health of the force and dependents in non-deployed settings—arose in a period of time when medicine was less specialized and theater medical care included significantly longer-term care than is currently practiced. The dual missions have diverged in nature, and thus are less complementary today than in previous eras.[28] In OIF and OEF in particular, in-theater medical care was more specialized than in previous operations, with a greater focus on immediate life-saving procedures and swift evacuation of patients to out-of-theater hospitals.[29] The workload in MTFs has only a limited ability to prepare medical personnel for deployment.[30] Of the 558 cases in which a patient died of wounds after reaching a theater hospital between October 2001 and June 2009, 51.4 percent died of potentially survivable injuries.[31]

To illustrate the challenge of staying ready for combat medicine while working at an MTF, Table 11 provides the top 10 inpatient diagnosis groups in the military hospital system in 2015 and Table 12 provides the top 10 inpatient diagnosis groups in Iraq in 2007.[32] The two lists share no diagnosis groups between them. MTF workload is predominantly concerned with pregnancy, childbirth, and conditions associated with aging. Theater workload is predominantly concerned with trauma.

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27 Ibid.

28 Transitioning from peace to war has proven difficult for US and foreign medical forces for centuries. See Bernard Rostker, "Providing for the Casualties of War: The American Experience through World War II" (Santa Monica, CA: The RAND Corporation, 2013), https://www.rand.org/pubs/monographs/MG1164.html.

29 DoD, "Final Report: DoD Force Health Protection and Readiness."

30 Joshua A. Tyler et al., "Combat Readiness for the Modern Military Surgeon: Data from a Decade of Combat Operations," *Journal of Trauma and Acute Care Surgery* 73, no. 2 supp 1 (August 2012): S64–70, doi: 10.1097/TA.0b013e3182625ebb.

31 Eastridge et al., "Died of Wounds on the Battlefield."

32 The diagnoses were aggregated by Clinical Classification Software (CCS) groupings before ranking.

Table 11. Top 10 Inpatient Diagnoses in Military Hospitals, 2015

Clinical Classification Software (CCS) Grouping	Dispositions
Newborn care	48,490
Normal pregnancy and delivery	46,947
Complications of pregnancy	45,427
Unclassified care	44,281
High blood pressure	43,701
Perinatal conditions	37,695
Screening/history of mental health and substance abuse	36,403
Complications of pregnancy - care of mother	32,708
Disorders of lipid metabolism	31,305
Nutritional, endocrine, and metabolic disorders	27,887

Table 12. Top 10 Inpatient Diagnoses in Iraq, 2007

Clinical Classification Software (CCS) Grouping	Dispositions
Open wounds of head, neck, and trunk	3,488
Open wounds of extremities	2,650
Other injuries and conditions due to external causes	2,274
Fracture of lower limb	992
Nonspecific chest pain	986
Abdominal pain	683
Crushing injury or internal injury	589
Other specified and classifiable external causes of injury	571
Fracture of upper limb	563
Skin and subcutaneous tissue infections	543

Previous IDA research used theater medical data as illustrated in Table 12 to identify requirements for readiness-relevant medical workload, and quantified the number of providers the MHS could support at various benchmarks.[33] To illustrate this, Table 13 provides the total AC military medical force in our eight occupations of focus. The second column comes from the July 2016 personnel file provided by DMDC. The third column represents hours worked in MTFs in terms of full-time equivalents (FTEs) in 2016 according to Medical Expense and Performance Reporting System (MEPRS) data. The fourth column represents an estimated number of supported providers for each occupation considered based on the previous IDA research.[34] Although the IDA research

33 Lurie et al., "Medical Readiness."

34 The supported FTE values assume that workload is efficiently allotted so that a provider that receives any workload receives enough to be ready. If, on the contrary, workload were uniformly allocated over all providers, no provider would have sufficient workload.

from which the supported FTEs are derived only performed the analysis for CONUS MTFs, the values in the fourth column are estimated under the assumption that Outside Continental United States (OCONUS) facilities support the same share of total FTEs as CONUS facilities. While most military physicians work in an MTF, they spend, overall, a small portion of their time on readiness-related workload.

Table 13. Total AC Force and MTF FTEs, 2016

Occupation	Total AC Force	MHS FTEs	Supported FTEs
Anesthesiology	458	366.4	20.3
Cardiac/Thoracic Surgery	33	34.9	4.7
Emergency Medicine	780	455.9	75.2
General Surgery	655	333.2	54.7
Neurological Surgery	64	50.1	19.7
Oral Maxillofacial Surgery	269	163.1	33.5
Orthopedic Surgery	534	391.4	66.7
Peripheral Vascular Surgery	55	47.3	6.4

C. Comparability of Military and Civilian Trauma Systems

This paper introduces options for AC providers to develop readiness in civilian trauma systems, and for the military to recruit providers into the RC who are already working in civilian trauma systems. To gauge the relevance of this type of experience to readiness both overall and across the stages of emergency care, it is important to understand how the deployed setting compares to the civilian trauma system. Differences between military and civilian systems may represent a challenge for providers who seek to maintain their readiness in civilian systems.

The American College of Surgeons (ACS) divides civilian trauma centers into three levels based on comprehensiveness of trauma care and number of admissions.[35] State governments also designate trauma centers, and may designate fourth or fifth levels for less capable trauma centers. Level 1 and 2 trauma centers offer a full range of specialties and equipment at all hours. Level 3 trauma centers generally staff some surgical specialties but not others. Level 4 and 5 trauma centers (which can exist in state designations) can evaluate and stabilize patients, and may have limited surgical capability. Patients who are too severely injured to be appropriately treated at their current location will be transferred to a higher-level facility.

[35] National Academies of Sciences, Engineering, and Medicine, *A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths after Injury* (Washington, DC: The National Academies Press, 2016).

The JTTS was based on civilian trauma systems, but adapted for operational goals and constraints.[36] Therefore it is no surprise that the JTTS and civilian trauma systems have some comparability in terms of emergency medical capability at roles and levels, respectively. Table 14 illustrates this comparison. For brevity, we list the Army entities in each role. Similar entities exist for Roles and 1 and 2 in the Marine Corps and for Roles 2 and 3 in the Air Force and Navy. Table 14 suggests that the civilian trauma system offers readiness-relevant experience to personnel throughout the range of CCC delivery.

Table 14. Military and Civilian Emergency Medical Capabilities

Role	Army Entity	Expected Provider Capabilities	Civilian Entity
1	First responder; Combat Medic; Battalion Aid Station	Primary care and emergency medicine physicians	First responder; Paramedic; Emergency department; Level 4 or 5 trauma center
2	Forward Surgical Team (FST)	General and orthopedic surgeons	Level 3 trauma center
3	Combat Support Hospital (CSH)	General, orthopedic, thoracic, oral/maxillofacial, and possibly other surgical specialists	Level 2 trauma center
4	Large out-of-theater hospital	All surgical specialties	Level 1 or 2 trauma center

Sources: Miguel A. Cubano, Martha K. Lenhart, U. S. Army, and Office of the Surgeon General, *Emergency War Surgery.* 4th ed.; Andrew J. Schoenfeld, “The Combat Experience of Military Surgical Assets in Iraq and Afghanistan: a Historical Review,” *The American Journal of Surgery* 204, no. 3 (September 2012): 377–83.

It is important to point out, however, that this comparability is not absolute and there can be significant divergence in specific areas. We note four caveats. First, trauma center designation is an imperfect indicator of capability. For example, Landstuhl Regional Medical Center in Germany, the Role 4 facility that supported OIF and OEF, was designated as a Level 1 trauma center in 2011, but was downgraded to Level 3 in 2014 due to a lack of admissions.[37] On the other hand, a Level 3 trauma center may see a volume of patients typical of a Level 1 trauma center, but not have the specialty coverage required for designation at a higher level.

Second, many military medical facilities are modular. For example, a fully configured CSH comprises two independently functional 84-bed and 164-bed hospital

[36] William C. Schwab, “Crises and War: Stepping Stones to the Future,” *Journal of Trauma and Acute Care Surgery* 62, no. 1 (January 2007): 1-16.

[37] Matt Millham, “With Fewer War Injuries, Landstuhl Becomes Level III Trauma Center,” *Stars and Stripes*, May 28, 2014, accessed March 6, 2017, http://www.stripes.com/news/with-fewer-war-injuries-landstuhl-becomes-level-iii-trauma-center-1.285819#.WL2zjPkrJhE.

companies. The 84-bed company itself comprises a 44-bed early-entry hospitalization element and a 40-bed augmentation. Specialty teams, such as head-and-neck, pathology, or renal hemodialysis, may further augment a CSH. The size and staffing of a CSH depends on mission-specific bed requirements.

Third, the nature of trauma, and therefore trauma care, differs across the deployed and civilian settings. During OIF, 80 percent of patients in an Iraq CSH suffered penetrating trauma, compared to 7 percent of patients at a Level 1 trauma center.[38] Further, surgeons in theater must treat a wide variety of cases that would be treated by specialists in a civilian system, and must do so under constraints on resources such as blood.[39]

Fourth, civilian trauma systems depend on rapid evacuation of the most severely injured patients to higher-level facilities. The JTTS similarly employs rapid evacuation to higher roles of patients who cannot promptly return to duty. Advances in aeromedical evacuation led to minimal mortality among patients evacuated to Landstuhl Regional Medical Center during OIF and OEF.[40] The success of aeromedical evacuation out of theater requires air superiority. In the absence of air superiority, medical specialists will need to be in-theater to provide care to patients. In particular, a Role 3 facility, as the most capable accessible facility, will need to have all specialties available.

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[38] Martin A. Schreiber et al., "A Comparison between Patients Treated at a Combat Support Hospital in Iraq and a Level I Trauma Center in the United States," *Journal of Trauma and Acute Care Surgery* 64, no. 2 (February 2008): S118–22, doi: 10.1097/TA.0b013e318160869d.

[39] DuBose, et al., "Preparing the Surgeon for War."

[40] Nichole Ingalls et al., "A Review of the First 10 Years of Critical Care Aeromedical Transport during Operation Iraqi Freedom and Operation Enduring Freedom: The Importance of Evacuation Timing," *Journal of the American Medical Association Surgery* 149, no. 8 (August 2014): 807–13, doi: 10.1001/jamasurg.2014.621.

5. Current Medical Force Readiness

A. Defining Medical Force Readiness

At the individual level, medical readiness is the ability to proficiently provide care in a deployed setting. At the force level, this translates to an ability to support operations by meeting deployment demands for medical personnel. A force seeks not only to meet current demands, but to meet demands in future periods. The magnitude of current and future demands that a force can meet is a measure of readiness.

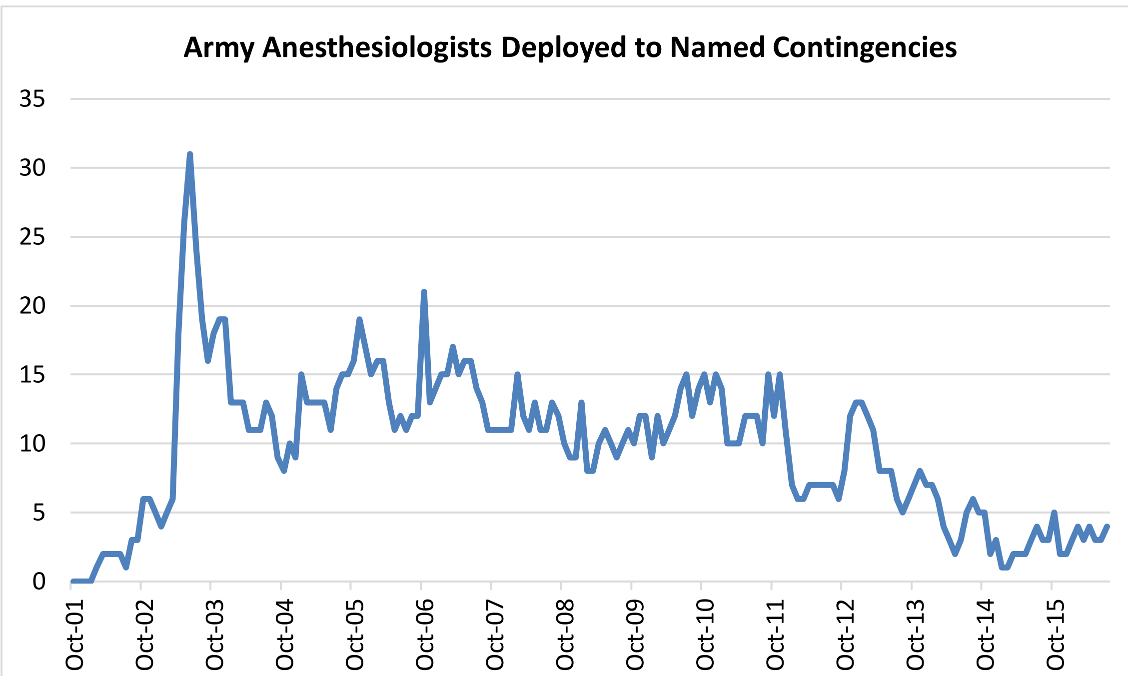
Deployment demands vary in size and predictability over time. A set of deployment demands may feature a short, intense surge of high demands followed by a long, predictable stream of low demands. The length and intensity of the surge demands will affect what force mixes are able to meet them. In general, a set of deployment demands has a shape over time. To appropriately compare force mixes, it is necessary to apply the same set of deployment demands to each force mix considered.

Given a set of deployment demands and a set of planning factors (e.g., rotation policy), we can define force readiness as the maximum scale of those demands that the force could meet. In other words, we ask, "What is the maximum factor we could multiply each period's demands by and still meet all of them?" We calculate this maximum factor at the Service-specialty level. We then aggregate the factors to the specialty level, weighted by each Service's number of deployment-months demanded for that specialty over all periods. To aggregate the factors to the DoD level, we weight by each specialty's total number of deployment months demanded over all periods. The result is the total number of deployment months the force could support divided by the total number of deployment months actually encountered.

To provide a simple, unclassified demand for medical forces, we use actual CTS data from October 2001 to July 2016, which spans the beginning of OEF to the most recent month of data available to us. For each Service and medical specialty, we observe the number of personnel deployed to named contingencies in each month. We do not observe deployments in the CTS data that are not to named contingencies. To take these into account, we notionally create a demand for these additional deployments in each month by using the Service- and specialty-specific mean number of personnel deployed to named contingencies over all months. We add this to the total demand to create a baseline of non-named contingency demand.

We also identify events to which only AC personnel can be deployed because there is not sufficient notice to activate RC forces. The obvious event that meets this requirement is the beginning of OEF (October 2001). To ensure a robust accessibility requirement in our demand data, we also assume that the beginning of OIF (March 2003) and the OIF surge (January 2007) were effectively unexpected events. This was not true in practice, but we impose this as a requirement to ensure we have "surprises" that highlight the need for accessible forces in our trade off analysis.

Figure 3 illustrates monthly CTS observations, using Army anesthesiologists as an example set of Service- and specialty-specific deployment demands. The shape of deployment demands over time in Figure 3 is roughly representative of deployment demands overall and for each occupation we consider (see Figure 1 on page 9). Deployments rose sharply in early 2003 with the beginning of OEF, dropped, and then rose again in 2005. Since 2006, deployments have trended downward as operations in Iraq have diminished.



Source: DMDC personnel files and CTS data.

Figure 3. Example of Service- and Specialty-Specific Monthly Counts of Deployed Personnel, October 2001–July 2016

Actual historical deployments represent how deployed units were manned in practice, during a time in which DoD was learning about how to improve theater healthcare delivery. Applying the lessons of OIF/OEF would lead DoD to respond to new wars of a similar nature with a different set of deployment capabilities. To address this, we construct an alternative set of deployment demands over the same timeframe based on unit deployments, with unit manning enhanced to reflect ACS trauma center designation criteria (see Table 14 on page 24). In particular, we man (1) all Role 2 entities with three general surgeons[41] and an orthopedic surgeon, and (2) all Role 3 entities with five general surgeons,[42] five orthopedic surgeons, five anesthesiologists, and one surgeon of each other focus occupation. While these quantities may satisfy ACS staffing guidelines, they are still significantly below trauma center averages.[43] For example, the mean number of orthopedic surgeons among trauma centers in the 2009 National Trauma Data Bank was 10.2 for Level 1 and 2 trauma centers and 6.9 for Level 3 and 4 trauma centers.[44] However, they represent a significant increase in deployment demands compared to actual deployments. An alternative interpretation of the enhanced demand scenario could be that it represents a potential future engagement in which more care must be delivered in theater (e.g., reduced ability to evacuate out of theater). Further study would be required to identify a more precise staffing demand level for each facility under such a scenario.

B. Method of Determining Maximum Scale Factors

In general, whether or not a force can meet a set of current and future deployment demands is not straightforward to answer. The irregularity of deployment demands over time combined with restrictions on how quickly, how long, and how often individuals may be deployed gives rise to a constrained optimization problem.

We apply three classes of constraints on deployed forces. First, forces must meet each period's deployment demands. Second, we identify three events to which personnel may not be deployed until their respective start periods: (1) the beginning of OEF (October 2001), (2) the beginning of OIF (March 2003), and (3) the OIF surge (January 2007). Third, personnel must deploy for a fixed amount of time and may not deploy again for a fixed number of periods following deployment.

We construct the constraints to reflect that the force must be able to sustainably meet the requirements. In other words, the scenario may be viewed as infinitely repeating. This is important for taking into account dwell times that extend beyond the scenario timeframe. For example, a non-repeating scenario cannot fully account for the opportunity cost of deploying a Reservist (i.e., not being able to deploy again over the next three to five years) near the end of the timeframe.

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41 In actual practice, the requirement is for the lead surgeon to be a trauma surgeon, but this was not addressed in this paper.

42 As with Role 2, the actual requirement is for some of these surgeons to be trauma surgeons.

43 Mark Faul et al., "Trauma Center Staffing, Infrastructure, and Patient Characteristics that Influence Trauma Center Need." *Western Journal of Emergency Medicine* 16, no. 1 (January 2015): 98.

44 Ibid.

These constraints require identification of the following deployment planning factors for each type of personnel:

- The number of periods from the start of an event that must pass before personnel may deploy to it ("lead time"),
- The number of consecutive periods for which personnel are deployed ("deployment duration"), and
- The number of periods that must pass between deployments ("dwell time").

In Table 15, we provide Service deployment planning factors for determining medical force requirements. Air Force and Navy rotation and duration planning factors are straightforward. Air Force personnel deploy for six months, after which AC personnel dwell for at least 12 months and RC personnel dwell for at least 30 months. Navy personnel deploy for 12 months, after which AC personnel dwell for at least 36 months and RC personnel dwell for at least 60 months. The Army considers a "steady-state" rotation policy of 1:3 and 1:5 for the AC and RC, respectively, as well as a "surge" rotation policy of 1:2 and 1:4 for the AC and RC, respectively.[45] As we are including surge requirements, we use the Army surge rotation policy of 1:2 for AC and 1:4 for RC.[46] Army RC personnel deploy for 9 months, as opposed to 12 months for the AC. Across the Services, while AC personnel may deploy with little or no notice, RC personnel must have a lead time of 30 or more days, with a goal of 90 days.[47]

Table 15. Deployment Planning Factors for Medical Force Requirements

	Rotation		Duration (Months)		Minimum Lead Time (Days)	
Service	**AC**	**RC**	**AC**	**RC**	**AC**	**RC**
Air Force	1:2	1:5	6	6	0	30
Army	1:3-1:2	1:5-1:4	12	9	0	30
Navy	1:3	1:5	12	12	0	30

Sources: Rotation and duration: DoD, "Report on Military Health System Modernization: Response to Section 713 of the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015." Lead time: David S. C. Chu, Memorandum to Secretaries of the Services, "Revised Mobilization/Demobilization Personnel and Pay Policy for Reserve Component Members Ordered to Active Duty in Response to the World Trade Center and Pentagon Attacks – Section 1," March 15, 2007.

45 Joshua Klimas et al., "Assessing the Army's Active-Reserve Component Force Mix" (Santa Monica, CA: The RAND Corporation, 2014), https://www.rand.org/pubs/research_reports/RR417-1.html.

46 The planning factors act as upper bounds on deployment tempo. Optimal individual dwell periods vary over persons and time, depending on the size and shape of demands. In times of low demands, optimal dwell times are likely to be longer than required by the planning factors.

47 David S. C. Chu, Memorandum to Secretaries of the Services, "Revised Mobilization/Demobilization Personnel and Pay Policy for Reserve Component Members Ordered to Active Duty in Response to the World Trade Center and Pentagon Attacks – Section 1," March 15, 2007.

C. Results

Table 16 reports maximum scale factors under varying readiness assumptions. The second column assumes that the entire current force (AC and RC combined as of July 2016) is ready. Over the eight considered occupations, the current force, if fully ready, could support deployment demands 2.22 times the magnitude of those encountered during OIF/OEF, given the same shape of demands over time. The third column limits the AC to the number of FTEs worked by AC personnel in MTFs in 2016, but imposes no readiness limitation on the RC. Under this limitation, the force could support nearly twice the deployment demands encountered in OIF/OEF.

The fourth column limits the number of AC providers stationed in MTFs to the number currently supported by MTF workload, but again imposes no readiness limitation on the RC. These limits are derived from previous IDA work on CONUS facilities[48]—distributed proportionally to manpower across the Services—and then inflated to account for OCONUS facilities, for each Service-specialty combination.[49] The limits do not account for inefficiencies in the distribution of workload across providers, and so represent an upper limit on the number of providers that can be kept ready by MTF workload. The analysis also allows for deployed workload to support additional AC providers, up to the limits of the personnel planning factors. The force that could be supported by relevant workload could meet 71 percent of actual OIF/OEF deployment demands. The fifth column imposes the same limitation as in the fourth column, but also assumes that half of the current RC force is not ready. This excursion shows that such a force could meet about half of actual OIF/OEF deployment demands with ready personnel.

Table 17 reports maximum scale factors across the same set of readiness assumptions as in Table 16, but imposes enhanced unit manning as described in Section 5.A. The force readiness factors are about one-third as large as the corresponding values in Table 16, which indicates that the enhanced demands are about three times as strenuous as the actual OIF/OEF deployments. The current force, even if fully ready, would not be able to meet the set of enhanced demands under the planning factors described in Table 15. As in Table 16, the force readiness factor decreases as the portion of the force considered to be ready is progressively limited.

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48 Lurie et al., "Medical Readiness."

49 We assume that OCONUS facilities can support the same share of current providers with major trauma workload as CONUS facilities.

Table 16. Force Readiness Factors, Actual OIF/OEF Deployments

	Number of OIF/OEFs Supported			
Occupation	Current Total Force	AC Limited to MTF FTEs	AC Limited by Current MTF Workload	AC Limited by Current MTF Workload; RC Half Ready
Anesthesiology	2.66	2.62	0.60	0.42
Cardiac/Thoracic Surgery	0.98	0.97	0.48	0.31
Emergency Medicine	2.27	1.93	0.82	0.53
General Surgery	1.74	1.37	0.57	0.37
Neurological Surgery	2.86	2.49	1.61	1.20
Oral Maxillofacial Surgery	4.60	3.49	1.20	0.93
Orthopedic Surgery	2.49	2.31	0.78	0.58
Peripheral Vascular Surgery	1.75	1.68	0.51	0.39
Average	**2.22**	**1.93**	**0.71**	**0.48**

Table 17. Force Readiness Factors, Enhanced Demands

	Number of OIF/OEFs Supported			
Occupation	Current Total Force	AC Limited to MTF FTEs	AC Limited by Current MTF Workload	AC Limited by Current MTF Workload; RC Half Ready
Anesthesiology	0.67	0.67	0.19	0.11
Cardiac/Thoracic Surgery	0.35	0.35	0.17	0.11
Emergency Medicine	0.79	0.69	0.29	0.19
General Surgery	0.65	0.52	0.21	0.14
Neurological Surgery	0.62	0.57	0.37	0.28
Oral Maxillofacial Surgery	1.99	1.63	0.54	0.43
Orthopedic Surgery	0.62	0.58	0.20	0.15
Peripheral Vascular Surgery	0.42	0.42	0.11	0.09
Average	**0.71**	**0.63**	**0.23**	**0.16**

6. Expanding Force Mix Options

The current medical force comes from two primary sources: AC personnel stationed in an MTF and RC personnel who may or may not have a civilian occupation that contributes to their medical readiness. Civilians also work in MTFs, but do not contribute to the operational medical mission by providing deployable capability. The deployment planning factors in Table 15 describe how AC and RC personnel can contribute to the operational medical mission. In this chapter, we explore alternative options for generating deployable medical personnel. Essentially, each option is a method for expanding medical workload beyond DoD beneficiaries to civilian cases. We identify five such methods, three in the AC and two in the RC.

Together, these analyses yield four alternative force mix options that will be analyzed in Chapter 7: (1) AC in MTFs that have been expanded to become DoD-owned or military-civilian partnership trauma centers, (2) AC in civilian trauma centers, (3) redesigned operational RC, and (4) strategic RC. These options should be thought of as representative of an even larger set of potential options, e.g., use of dual status military technicians or a Department of Health and Human Services Reserve civilian model. The selected options represent the range of functional relationships DoD could have with the force: full-time on military base, full-time off military base, part-time, and a pool of reach-back support only accessed in a major war. The actual contracting arrangements could be adjusted based on further implementation analysis.

A. Active Component

We consider three options for exposing AC medical personnel to civilian workload that contributes to medical readiness. All of these options involve treating civilians in trauma centers. The options vary by the administrative nature of the facility in which the personnel are stationed. The attractiveness of each option varies with market characteristics.[50] Each option requires cooperation with civilian trauma care providers.

The three places we consider stationing an AC physician are:

- **An MTF designated as a trauma center**: Four MTFs have trauma center designation from US states, meaning they may accept civilian trauma patients. Only one, SAMMC, treats a significant number of civilian trauma cases. This

[50] For case study analyses of these options in specific markets, see Lurie et al., "Medical Readiness."

option is best suited for the largest DoD hospitals operating in markets that are not already saturated with civilian trauma services. This option entails an up-front cost of upgrading a facility to meet designation criteria, in addition to the cost of staffing surgical specialties to meet designation criteria. It has the advantage of introducing no operational impediments—military providers remain ready to deploy on minimal notice.

- **A joint military-civilian trauma center**: In many markets, there exist both an MTF and a robust civilian trauma care capability. In such areas it may be mutually beneficial to combine DoD and civilian resources to improve the overall trauma system for the local area. These jointly (in the military-civilian sense) administered trauma centers could be located at the civilian partner's facility or the military hospital, or be spread across both the military and civilian facilities, depending on market circumstances. This option, while unprecedented, is consistent with the vision of a "National Trauma Care System."[51] This option would entail some costs of adapting facilities to meet designation criteria, although the civilian facility may bear some of the costs. However, it may also entail some savings, as the MTF may be able to reduce some overhead functions and non-military essential activities that are already being performed by the civilian facility. The MTF would need to negotiate and maintain a memorandum of agreement (MOA) with the civilian facility. The MOA may include restrictions on the speed or magnitude at which the MTF may remove personnel from the facility due to change of station or deployment. The civilian partner would likely require assurance that trauma center staffing would not decrease so much under these circumstances as to endanger trauma center designation. For a detailed discussion of opportunities, challenges, and options for overcoming challenges, see Lurie et al. (2017).[52]
- **A civilian trauma center**: In markets where there is not enough workload to support a DoD trauma center and jointly run military-civilian trauma centers are not feasible, military providers could be stationed permanently in civilian trauma centers. Civilian facilities may be selected for these arrangements based on factors such as proximity to the military installation, magnitude of trauma workload, and cooperativeness of the facility leadership. This option builds on many instances of military providers training in civilian facilities, which are primarily short-term arrangements directly prior to deployment.[53] This option would incur an opportunity cost in that military providers reassigned to civilian

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51 National Academies of Sciences, Engineering, and Medicine, *A National Trauma Care System.*

52 Lurie et al., "Medical Readiness."

53 DuBose et al., "Preparing the Surgeon for War."

facilities would otherwise have been available to treat patients in the MTF. It may entail some monetary benefit to the extent that civilian facilities are willing to compensate the MTF for the providers' labor. In some markets, civilian providers may welcome the additional help in delivering trauma care to the local community. In other markets, civilian providers may be averse to additional competition for workload.[54] As in the military-civilian option above, an agreement with a civilian trauma center may include restrictions on the speed or magnitude at which the MTF may remove personnel from the facility due to change of station or deployment.

Training military personnel in civilian trauma centers is not a new concept. In 1998, the General Accounting Office (GAO) found:

> "[s]ince most military treatment facilities provide health care to active duty personnel and their beneficiaries and do not receive trauma patients, military medical personnel cannot maintain combat trauma skills during peacetime by working in these facilities. In contrast, civilian trauma centers are specialized hospital facilities with immediately available health care providers and equipment to care for severely injured trauma patients, such as those with penetrating stab or gunshot wounds."[55]

Quantitative data support GAO's claim. Table 18 lists the 10 most common patient diagnoses in US civilian trauma centers in 2013, for comparison with Table 11 and Table 12 (page 22).[56] Trauma center workload is vastly more similar to theater workload, with half of the diagnoses on the two lists shared between them. All of the nine most common diagnoses in civilian trauma centers in 2013 are among the 20 most common diagnoses in Iraq in 2007.

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[54] While willingness to accept assignments of AC personnel would vary across civilian facilities, a 2008 RAND report found that "civilian medical organizations are generally receptive to the idea." See Christine Eibner, "Maintaining Military Medical Skills during Peacetime: Outlining and Assessing a New Approach" (Santa Monica, CA: The RAND Corporation, 2008), https://www.rand.org/content /dam/rand/pubs/monographs/2007/RAND_MG638.pdf.

[55] General Accounting Office, "Medical Readiness: Efforts Are Underway for DOD Training in Civilian Trauma Centers," GAO/NSIAD-98-75 (Washington, DC: GAO, April 1998), 12, http://www.gao.gov/assets/160/156122.pdf.

[56] This list was constructed from a sample of approximately 100 trauma centers, constructed and weighted to be nationally representative.

Table 18. Top 10 Inpatient Diagnoses in Civilian Trauma Centers, 2013

Clinical Classification Software (CCS) Grouping	Estimated Dispositions (Thousands)
Other fractures	333
Intracranial injury	298
Superficial injury; contusion	297
Crushing injury or internal injury	254
Open wounds of head; neck; and trunk	225
Fracture of lower limb	179
Fracture of upper limb	160
Skull and face fractures	155
Open wounds of extremities	113
Fracture of neck of femur (hip)	61

Source: National Trauma Data Bank National Sample Program.

B. Reserve Component

We consider two options for RC personnel:

- **An operational "high-tether" Reserve**: This first option emulates the current RC concept, augmented by stricter monitoring of readiness. For the specialties considered in this paper, this is unlikely to incur significant cost to DoD, as regular measurement of clinical currency already exists for other purposes. DoD could require that the Reservist send or upload to a website documentation of clinical currency on a regular—e.g., annual—basis as a term of the Reserve contract. This would ensure that RC medical personnel are maintaining their medical readiness through their civilian occupations.

  The operational Reserve concept implies regular deployment, which may negatively affect recruitment and retention. Therefore, we consider a cost multiplier (which could be awarded as additional special pay, for example) to compensate RC medical personnel in dwell periods. This would be independent of Active Duty pay that Reservists earn while activated.

- **A strategic "low-tether" Reserve**: A second option is to recruit organizations or individual personnel into a strategic Reserve, to be activated only under comprehensive federal call-up authority (10 U.S.C. § 12301(a)) or voluntarily (10 U.S.C. § 12301(d)). This is the least costly option of all considered, but would offer the least benefit in terms of accessibility.

  The concept of a strategic medical Reserve has current and historical precedent. Analogous programs in DoD include the Civil Reserve Air Fleet and the

Voluntary Intermodal Sealift Agreement, whereby DoD offers business to transportation companies in return for the authority to use allocated craft and crews in a national defense emergency.[57] Other nations have adopted similar programs. By the United Kingdom-sponsored Reserve system, contractors pledge a share of their workforce as Reservists in return for government business.[58] The Canadian military offers medical specialists, including those in the occupations considered in this paper, an option to serve the Canadian Reserve Force for a minimum of 14 days of service and/or training per year.[59]

The use of civilian hospital staff in a Reserve role has historical precedent in the United States. In World Wars I and II, the United States established an "affiliated Reserve" of civilian hospitals.[60] The hospitals would offer "completely integrated units with harmonious staffs of competent and qualified physicians and surgeons, which would be sufficiently coordinated and organized to be able to function in a theater of operations with a minimum of delay."[61] Leading up to World War II, more hospitals were eager to join the affiliated Reserve than the Army was willing to take; in 1941, 56 hospitals and over 1,500 medical personnel so joined.

Another model for a strategic Reserve is the National Disaster Medical System (NDMS), operated by the US Department of Health and Human Services (HHS). According to the HHS website:

> When their NDMS teams are activated in response to a disaster, these professionals serve as members of NDMS teams – and they are ready to respond within hours of being activated. They deploy to assist during disasters and emergencies, providing expert care and services in conditions that are often austere and challenging.[62]

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57 "Civil Reserve Airfleet Allocations," US Department of Transportation, Office of Intelligence, Security and Emergency Response, https://www.transportation.gov/mission/administrations/intelligence-security-emergency-response/civil-reserve-airfleet-allocations; and "Voluntary Intermodal Sealift Agreement (VISA)," Maritime Administration (MARAD), https://www.marad.dot.gov/ships-and-shipping/strategic-sealift/voluntary-intermodal-sealift-agreement-visa/.

58 Air Force Logistics Management Agency, *2004 Logistics Dimensions: Readings in the Issues and Concerns Facing Air Force Logistics in the 21st Century, Volume 2* (Maxwell AFB, AL: Air Force Logistics Management Agency, 2004), 157–62.

59 "Medical Officer," Canadian Armed Forces, http://www.forces.ca/en/job/pdf/medicalofficer-50.

60 John H. McMinn and Max Levin, *Personnel in World War II* (Washington, DC: Office of the Surgeon General, Department of the Army, 1963), 141–8.

61 Ibid.

62 "Public Health Emergency: NDMS Teams," US Department of Health & Human Services, https://www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/default.aspx.

The NDMS includes Trauma and Critical Care Teams that typically deploy for 14 days or longer.[63] NDMS personnel must maintain medical licensure and certifications, complete training and drills, and remain medically and physically fit.[64] Like military personnel, NDMS personnel are covered by the Uniformed Services Employment and Reemployment Rights Act of 1994 (USERRA).

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63 "Public Health Emergency: Trauma and Critical Care Teams," US Department of Health & Human Services, https://www.phe.gov/Preparedness/responders/ndms/ndms-teams/Pages/tcct.aspx.

64 "Public Health Emergency: Commitments & Legal Protection," US Department of Health & Human Services, https://www.phe.gov/Preparedness/responders/ndms/commitment-protection/Pages/default.aspx.

7. Assessing Medical Force Mix

In this section, we assess alternative mixes of Active, Reserve, and civilian personnel for our selected occupations in terms of force readiness and cost. First, we calculate the cost of the current force in the context of the deployment requirements described in Chapter 5. Second, we consider the conversion of AC personnel to civilian, which decreases cost without harming readiness. Third, we consider expanding the RC force, which increases readiness and cost. Fourth, we consider the introduction of alternative force mix options, which decreases the cost of achieving a given readiness level compared to the current force mix options.

Three key attributes of the trade space between AC and RC performance are analyzed:

- **Accessibility**: How quickly, reliably, and often can forces be deployed? AC forces are generally more accessible.
- **Cost**: How much do the forces cost to maintain between deployments, i.e., during dwell time? RC forces are generally less costly in dwell.
- **Clinical Readiness**: AC forces in MTFs have significant clinical readiness challenges. RC forces, on the other hand, may have a higher level of clinical readiness than AC forces (e.g., an RC emergency medicine physician working in a busy civilian emergency department) or lower (e.g., an enlisted medic working in automotive repair for civilian employment).

A. Cost of the Current Force

In Chapter 5, we measured force readiness as the maximum scale of OIF/OEF deployments a force could sustainably support. Meeting the maximum scale of deployments implies an average annual cost, which includes both dwell and deployment costs. The cost estimates in Table 4, Table 5, and Table 6 (pages 6 and 7) represent annual dwell costs, which we convert to monthly costs to match the frequency of our deployment requirements. The deployed cost of an AC medical specialist is the dwell cost plus the cost of backfilling with a civilian of the same specialty.[65] The cost of a deployed or activated RC medical specialist is the AC deployed cost plus the quotient of

[65] Another option would be to replace treatment in the MTF with purchased care, which may provide further savings.

pre- and post-mobilization costs divided by the total duration of deployment and activation. We assume one month of activation in anticipation of each RC deployment.

The second and third columns in Table 19 display the current AC and RC force mixes for the occupations of focus. The fourth column displays the average annual cost of those forces meeting their maximum scale factors. In total, we estimate that these physicians would cost the federal government $1.58 billion per year; $1.37 billion of this total, or 86 percent, represents annual cash flow costs incurred by DoD, as shown in the fifth column.

Table 19. Current Force Mix and Cost

Occupation	AC	RC	Total Cost ($Mil/yr)	Cash Flow Cost ($Mil/yr)
Anesthesiology	458	221	257.7	222.5
Cardiac/Thoracic Surgery	33	28	21.7	18.6
Emergency Medicine	780	442	396.0	334.8
General Surgery	655	327	366.8	316.6
Neurological Surgery	64	43	40.5	35.2
Oral Maxillofacial Surgery	269	52	140.9	123.0
Orthopedic Surgery	534	171	323.6	285.8
Peripheral Vascular Surgery	55	9	32.5	28.7
Total	**2848**	**1293**	**1579.6**	**1365.3**

B. Military-to-Civilian Conversion

In Section 5.C, we showed estimated numbers of providers whose readiness could be supported by MTF workload. These numbers, adjusted for deployments, represent the maximum ready AC force. Because they cannot be kept ready, AC providers in excess of the number that can be supported by workload can be compared to civilian providers on a cost basis. The total cost of a civilian provider is generally lower than the total cost of a military provider. Thus, military-to-civilian conversion of those providers whose readiness cannot be supported by workload represents an opportunity to save money without harming readiness. It is important to emphasize this point. Conversion of these personnel is simply an improvement to the efficiency of force mix—thereby saving money—that is neutral with respect to readiness. The providers that are not ready are not meeting a deployment demand, so there is no military reason to keep them in uniform. Converting them to civilian provision saves money while having no impact on readiness.

To determine the maximum ready AC force, we must account for both MTF and deployed workload. Personnel deployment planning factors (Table 15, on page 30) determine how often and for how long providers can deploy, which, in the context of a set of deployment demands, determines the maximum readiness contribution of deployed workload. From the analysis described in Section 5.C, we estimate the maximum number of AC providers whose readiness can be supported by the sum of MTF and deployed workload. In particular, we observe the numbers of AC providers that lead to the results in the third column of Table 16.

Table 20 compares the maximum number of ready AC providers for each occupation of focus to the current force. Overall, we estimate that MTF workload can support the readiness of about 14 percent of all AC providers in the listed occupations. This workload-supported share represents an upper bound because it assumes optimal allocation of workload across providers. The fourth and fifth columns of Table 20 calculate the potential savings from replacing the AC personnel in excess of the maximum number of ready providers with civilians. Using the total costs from Table 4, Table 5, and Table 6 (pages 6 and 7), we estimate long-term savings to the federal government of $226.9 million per year. Using only DoD cash flow costs, we estimate short-term savings of $161 million per year.

Table 20. Savings from Military-to-Civilian Conversion

	AC Personnel		Savings from Conversion ($Mil/yr)	
Occupation	**Current**	**Max. Ready**	**Total Cost**	**DoD Cash Flow**
Anesthesiology	458	28	37.1	25.7
Cardiac/Thoracic Surgery	33	6	1.3	0.8
Emergency Medicine	780	107	81.2	59.0
General Surgery	655	79	47.0	32.0
Neurological Surgery	64	24	1.6	1.0
Oral Maxillofacial Surgery	269	46	29.1	22.4
Orthopedic Surgery	534	94	22.1	14.1
Peripheral Vascular Surgery	55	9	7.3	6.0
Total	**2,848**	**394**	**226.9**	**161.0**

C. Expanding the RC

One way that DoD could allocate savings gained from military-to-civilian conversion would be to expand the force to allow it to meet greater deployment demands. With AC force readiness limited by MTF workload, the current force mix options offer one channel for doing so: expanding the RC. In this section, we explore the relative increases in force readiness and cost associated with this option. That is, we estimate the marginal cost of readiness within the current force mix option set. To do so, we perform the same analysis as described in Section 5.B, but with increased levels of the RC force. We increase the number of RC personnel in each occupation and in each Service by a fixed percentage and observe the resulting cost (in millions of dollars per year) and force readiness factor (in number of OIF/OEFs). We consider a range of percentages and plot the results in Figure 4.

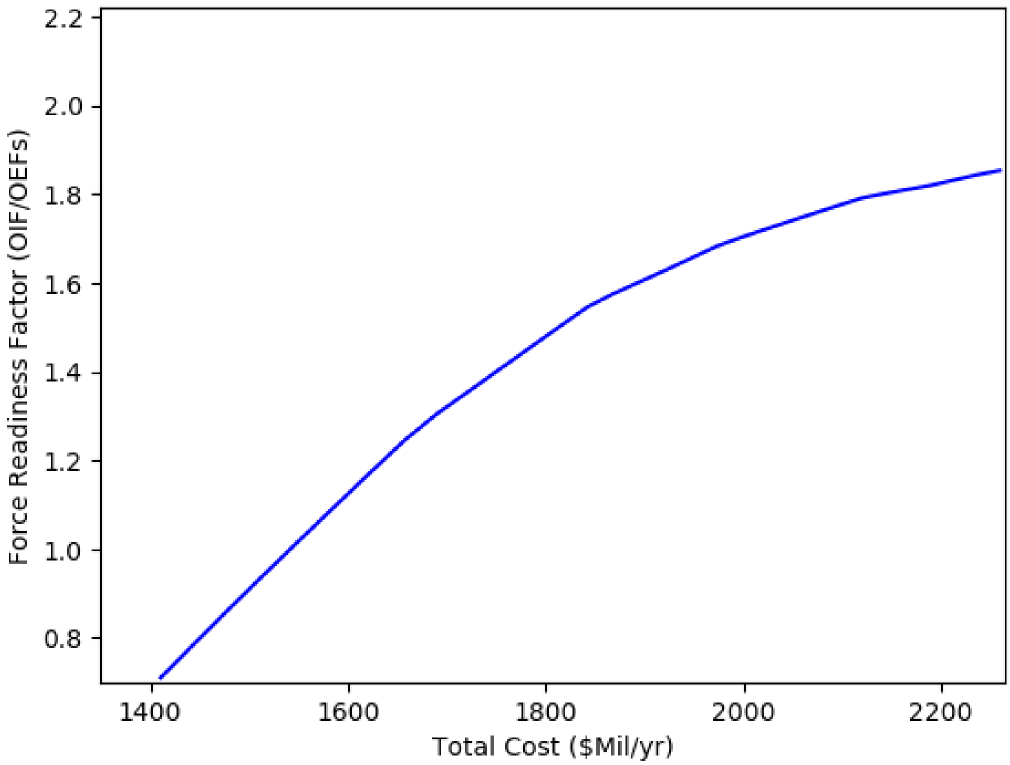

Figure 4. Effects of RC Expansion on Force Readiness and Cost

Figure 4 shows how force readiness and cost increase as the RC force expands. The left-most point represents a force composed of the current RC force, the maximum number of ready AC personnel supported by workload, and, for cost calculation, the civilians necessary to replace the remaining AC providers. Corresponding to the fourth column of Table 16 (page 32), this force can meet 0.71 OIF/OEFs.[66] The curve moves up and to the right as the RC force expands equally across all Services and occupations up to a seven-fold expansion (i.e., a 600 percent increase) at the highest point on the curve. A seven-fold RC expansion would increase the force readiness factor to 1.85 OIF/OEFs. The curve is bowed downward (concave), so that each successive increase in the RC force yields a smaller gain in force readiness. This is because, as discussed in the next section, the most urgent deployment demands cannot be met by RC personnel. A 20 percent increase in the RC force would increase the cost of the force from $1.41 billion

66 This force costs more than the cost of the current force (Table 19, column 4) minus the savings from military-to-civilian conversion (Table 20, column 4) because some deployment months currently served by unsupported AC personnel must be served by RC personnel instead, who, unlike AC personnel, cost more while deployed.

per year to $1.45 billion per year, a 2.8 percent cost increase, and increase the force readiness factor from 0.71 OIF/OEFs to 0.80, a 12.7 percent increase. The difference in the force readiness factor between 380 percent and 400 percent RC expansion is .02 OIF/OEFs, less than one quarter of the effect of a 20 percent expansion from the current level. However, only the largest increases in the RC force exhibit such significantly diminished returns. The difference in force readiness factor between 180 percent and 200 percent RC expansion is .05 OIF/OEFs, over one half of the effect of a 20 percent expansion from the current level.

D. Introducing Alternative Force Mix Options

Among the two current force mix options, only AC personnel may be deployed with no lead time.[67] Some deployment demands require immediate responses, and therefore may only be met by AC personnel. MTF workload can only support the readiness of a limited number of AC personnel. For most Service-specialty combinations, MTF workload does not support the number of AC personnel necessary to meet these immediate demands. Therefore, no matter the number of RC personnel, it is impossible to maintain a force that can meet all demands. Maintaining a fully ready force at a high level necessitates additional force mix options. The expanded option set guarantees a solution at some cost by virtue of the option of placing AC personnel in civilian trauma centers, which is not limited by MTF workload.

We therefore optimize the force given the alternative options described in the previous chapter. For the purposes of this analysis, there are two AC options: AC personnel in MTFs that have been expanded to become trauma centers (either stand-alone or through military-civilian partnerships) and AC personnel permanently assigned to civilian trauma centers. Treating DoD beneficiaries is equivalent to the current MTF option, including being constrained by MTF workload. The number of ready AC personnel treating civilian patients is not constrained by MTF workload. However, these personnel are much more expensive because they are not contributing to the beneficiary care mission. Strategic RC personnel are the least expensive option, but would deploy the most rarely.

For a given set of temporal deployment demands and force mix constraints, we find the mix of personnel that minimizes the cost of meeting the demands in each period, keeping beneficiary care delivery constant. We compare the cost of the current force mix to the costs of optimized force mixes that can meet varying deployment demands, including demands that are impossible to meet with the current force mix options. We

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[67] DoD Instruction 1235.12, "Accessing the Reserve Components," governs lead time for RC activation. For time-critical emergent requirements, activation within less than 30 days requires Secretary of Defense approval.

perform each optimization at the Service-specialty level and aggregate the results to estimate total cost per year. Appendix C contains a technical explanation of our optimization method.

We require that, for each personnel type, the total number of deployed and non-deployed personnel be constant over the requirements timeframe. Technically, this is not a constraint, but a definition of the set of variables to optimize. By choosing a single, time-invariant quantity for each personnel type, we attain a well-defined optimum force mix for a given scenario and make the optimization process tractable.

1. Parameters

Differences between personnel types that affect the optimal force mix include:[68]

- Cost
  - While not deployed (“dwell cost”)
  - While deployed or activated in anticipation of deployment
- Deployment factors
  - Duration
  - Rotation
  - Lead time

For the dwell and deployed cost of AC personnel stationed in MTFs and operational RC personnel, we apply the same method as described in Section 7.A. That is, dwell costs come from Table 4, Table 5, and Table 6 (pages 6 and 7) and deployed/activated costs are AC dwell costs plus the costs of civilian backfilling (in the case of AC) or pre- and post-mobilization (in the case of RC). For deployment factors we use the values in Table 15 (page 30).

For AC personnel treating civilian patients, the military enjoys some cost-sharing with the civilian trauma system. As a baseline, we assume that the civilian trauma system pays 50 percent of the civilian cost.[69] We assume that the deployment cost and planning factors are identical for all AC personnel. For strategic RC personnel, we assume half the dwell cost, the same deployment duration and lead time, and four times the dwell time of

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[68] Klimas et al., *Assessing the Army's Active-Reserve Component Force Mix*.

[69] DoD has little experience with this arrangement to provide an empirical basis for the baseline parameter. See Eibner, “Maintaining Military Medical Skills during Peacetime,” for a review of interviews conducted with civilian hospitals that included discussion of their willingness to reimburse for military providers.

the operational RC. In Section 7.D.3, we examine the sensitivity of our results to alternative assumptions.

2. Principal Results

According to the results in Table 16 (on page 32), the current force, if fully ready, would have a force readiness factor of 2.22 OIF/OEFs. However, limiting the number of ready AC providers to those who can be supported by relevant workload decreases this factor to 0.71 OIF/OEFs. Because of immediate deployment demands in response to world events, expanding the RC alone cannot bring the force up to a readiness factor of 2.22. By introducing alternative force mix options, bringing the force to this factor is possible. These alternative options are (1) an AC physician stationed in a civilian hospital, and (2) an RC physician in a low-tether strategic Reserve. In addition, we alter the traditional RC contract to require that Reservists experience and report significant readiness-related workload in their civilian occupations. To accompany this additional contractual requirement, we increase RC cost by 30 percent.

The same IDA paper from which we derive MTF workload measures also recommended actions DoD could take to increase MTF workload.[70] The paper estimated that investing in the 11 MTFs large enough to be considered for investment and integration with civilian trauma systems could increase the share of MTF provider FTEs supported by major trauma workload from 28 percent to up to 46 percent. While we do not estimate the cost of this investment in this paper,[71] we do examine the implications of this upgraded MTF workload in the context of force mix. In the following analysis, we assume 64.3 percent (i.e., 0.46/0.28) greater readiness-relevant workload for AC personnel as a result of this investment. We continue to assume that this workload is optimally allocated across providers, meaning that we overestimate the number of AC providers whose readiness could be supported by MTF workload to the extent that individual providers receive insufficient or excess workload to maintain their readiness.

Among the four force mix options, we minimize the cost of meeting the same force readiness factors that the current force could meet if it were fully ready. We illustrate the results in Table 21, where each row represents the optimal mix of personnel for the stated occupation. Each option contributes to the optimum force mix for every occupation. This result is not guaranteed by the model; hypothetically, one or more options could have an optimal value of zero. Observing only positive values therefore attests to the viability of each option. MTF investment increases the optimum number of AC personnel in MTFs to

[70] Lurie et al., "Medical Readiness."

[71] If done as military-civilian partnerships, it is possible that costs would go down.

589, or about 11 percent of the force.[72] The optimal number of AC providers stationed in civilian hospitals is similar to the number stationed in MTFs. The high-tether operational RC option, despite the 30 percent cost multiplier, constitutes 66 percent of the optimum force. We find that the optimal number of AC providers stationed in civilian hospitals is close to the number of personnel required to meet immediate deployment requirements that cannot be met by providers stationed in MTFs. The low-tether RC option, under our cost and planning assumptions, would constitute a minority of RC personnel for each occupation, constituting 12 percent of the overall total. We estimate that a fully ready force with these options would cost $2.11 billion per year, 34 percent more than the current force.

Table 21. Force Mix and with Alternative Force Mix Options

Occupation	AC in MTF	AC in Civilian Hospital	High-Tether RC	Low-Tether RC	Total Cost ($Mil/yr)	Cash Flow Cost ($Mil/yr)
Anesthesiology	41	165	588	77	360.2	307.5
Cardiac/Thoracic Surgery	10	6	37	17	28.5	24.5
Emergency Medicine	167	157	973	235	511.9	428.4
General Surgery	119	126	923	102	503.2	427.6
Neurological Surgery	35	8	63	17	51.9	44.8
Oral Maxillofacial Surgery	59	34	262	71	172	146.7
Orthopedic Surgery	145	69	609	102	448.3	389.4
Peripheral Vascular Surgery	13	1	50	19	37.2	32.1
Total	**589**	**566**	**3506**	**640**	**2113.2**	**1801.1**

3. Sensitivity Analysis

The optimum force mix and associated cost depend on the values of parameters. In this section, we explore how sensitive the results are to changes in the parameters. We consider the following parameter changes:

1. Decreasing RC deployment duration to six or three months.
2. Increasing RC lead time to two or three months.
3. Altering the share of the cost paid by a civilian facility where AC personnel are stationed from 0 percent to 87.5 percent in increments of 12.5 percent.

[72] The optimum number of AC personnel in MTFs is generally capped by constant workload values, but can vary moderately based on the number of personnel worth keeping ready with deployments that are in excess of demands.

4. Altering the cost premium associated with requiring and monitoring the clinical proficiency of both the operational and strategic RC from 0 percent to 90 percent in increments of 15 percent.

Parameter changes 1 and 2 in the above list represent changes to RC planning factors that may limit the operational capability of the RC force, and therefore increase the cost of meeting a given set of deployment demands. Table 22 displays the optimized force mixes and associated costs corresponding to each of these two parameter changes. Each row is aggregated across all Services and occupations of focus, in the same manner as the "Total" row in Table 21.

Table 22 shows that the optimum force mix is moderately sensitive to changes in RC lead time and deployment duration, and that these changes have a small impact on cost. Setting RC deployment duration to six or three months (while maintaining the same ratio of deploy and dwell time) increases total cost by 0.7 percent and 1.2 percent, respectively. At an RC deployment duration of six months, the most prominent shift in force mix from the baseline is an increase in the low-tether RC option. At an RC deployment duration of three months, the shares of each option are similar to the baseline. Increasing RC lead time to two or three months increases total cost by 0.6 percent and 0.8 percent, respectively, and requires a slightly larger AC force. The parameter values affect cash flow cost and total cost similarly.

Table 22. Force Mix Sensitivity to RC Planning Factors

RC Lead Time (months)	RC Deploy Time (months)	AC in MTF	AC in Civilian Hospital	High-Tether RC	Low-Tether RC	Total Cost ($Mil/yr)	Cash Flow Cost ($Mil/yr)
1	6-12*	589	566	3506	640	2113.2	1801.1
1	6	606	571	3411	910	2128.5	1813.6
1	3	624	544	3638	554	2138.9	1821.9
2	6-12*	592	747	3220	634	2126.5	1818.9
3	6-12*	594	793	3136	651	2129.3	1822.9

* Deployment duration in the base case is 6 months for Air Force, 9 months for Army, and 12 months for Navy.

Note: The first row of data is taken from the "Total" row of Table 21.

Our analysis required assumptions on the costs of new (in the case of AC providers in civilian facilities and strategic RC) and improved (in the case of operational RC) force mix options. Parameter changes 3 and 4 on page 46 represent ranges of possible cost assumptions. For each possible combination of values in these ranges, we optimize force mix as in Section 7.D.2. We consider eight values for civilian facility cost share and seven values for RC cost multiplier, for a total of 56 optimized force mixes. In Figure 5 and Figure 6, we plot the cost of each combination of cost parameters and interpolate to illustrate estimated cost curves. Each curve corresponds to a specific value of the RC cost multiplier (denoted in the legend) and each point on the curve corresponds to a different civilian facility cost share (denoted on the horizontal axis). For example, the points marked by an orange circle in Figure 5 and Figure 6 are the points associated with our baseline parameters—a 30 percent RC cost multiplier and a 50 percent civilian cost share. Moving along the curve to the right increases the civilian cost share. Moving up to another curve increases the RC cost multiplier.

Larger RC cost multipliers are associated with higher curves and therefore higher costs. The curves are downward-sloping, meaning that cost decreases as the civilian cost share increases. Further, the downward slope of the curves is more extreme at higher values of the civilian cost share. This is because at higher values of the civilian cost share, more of the optimized force is stationed in civilian facilities, so a given increase in the civilian cost share brings greater savings. The costs plotted in Figure 5 and Figure 6 include the costs of AC and civilian personnel working in MTFs. These beneficiary care costs are not sensitive to the civilian cost share and RC cost multiplier, which limits the potential savings as a share of total costs.

Because we optimize with respect to total cost and because total costs and cash flow costs are not perfectly correlated across Services and personnel types, the total cost curves are smoother than the cash flow cost curves. Decreasing the total cost of a personnel type increases the optimum number of that type. If an especially large share of that type's cost is cash flow cost, it is possible for cash flow cost to rise due to substitution into that personnel type.[73] This leads to the relatively bumpy cash flow cost curves in Figure 6. In general, though, the cash flow cost curves follow the same pattern as the total cost curves.

[73] Cash flow costs include basic pay, allowances, and various individual benefits. Other costs, which change with the number of uniformed personnel only in the long run, include family support services and discount groceries. Section 2.B describes cost categories. Appendix B lists the elements in each category.

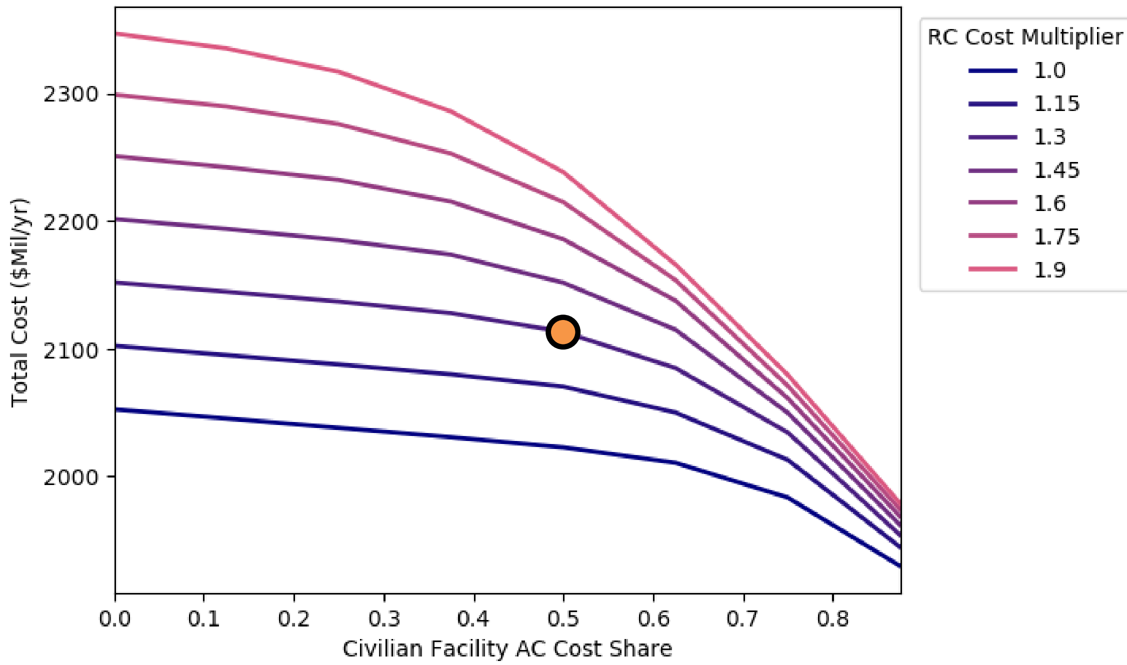

Figure 5. Annual Total Cost as a Function of Cost Parameters

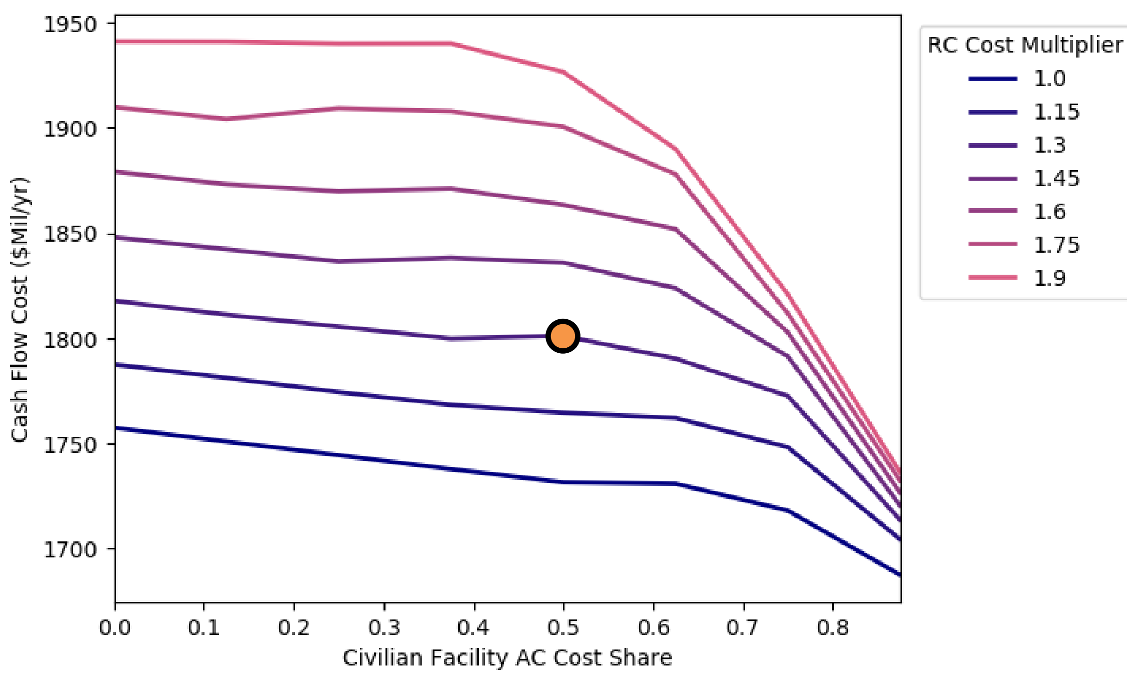

Figure 6. Annual Cash Flow Cost as a Function of Cost Parameters

Whereas the previous figures show costs, Figure 7 and Figure 8 show the optimum number of operational RC personnel and AC personnel stationed in civilian facilities, respectively, for the same tested combinations of the cost parameters. Each curve plots the number of personnel desired of the given type as a function of that type's cost. Thus, each curve is a traditional economic demand curve. As expected by the economic law of demand, the optimum number of personnel of a given type decreases as its cost increases (smaller civilian cost share means increased cost to the government).

Each curve represents a different level of the cost of the other personnel type. For example, redder curves in Figure 7 correspond to a greater civilian cost share and therefore a lower cost of stationing AC physicians in civilian facilities. Redder curves are lower, meaning that the optimum number of RC personnel decreases as the cost of the other option decreases. Thus, in economic terms, the two options are substitutes.

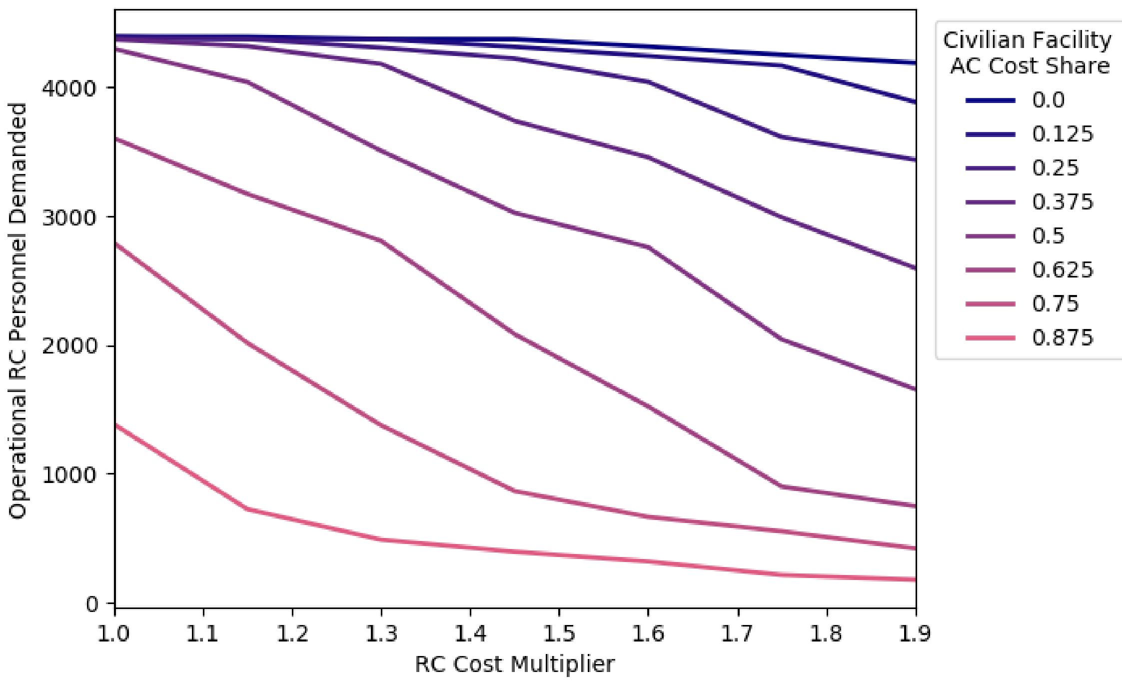

Figure 7. Optimum Number of Operational RC Personnel as a Function of Cost Parameters

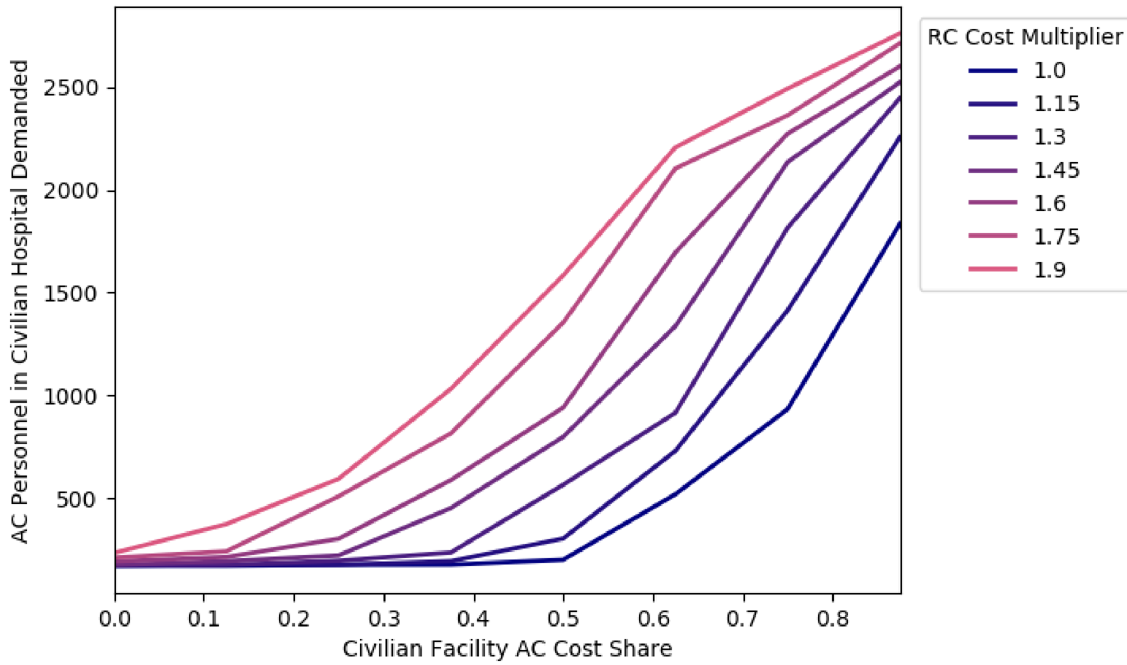

Figure 8. Optimum Number of AC Personnel Stationed in Civilian Facilities as a Function of Cost Parameters

For a wide range of cost parameters, the operational RC category remains the most represented in terms of number of personnel. After doubling the RC cost multiplier from 30 percent to 60 percent, the optimal number of operational RC personnel is still roughly three times the optimal number of AC personnel stationed in civilian facilities. Even at a 90 percent cost multiplier, the optimal number of RC personnel is greater than the optimal number of AC personnel stationed in civilian facilities. Even at a civilian cost share for AC personnel of 75 percent, the optimal number of RC personnel (with a 30 percent cost multiplier) is similar to the optimal number of AC personnel in civilian facilities. These results indicate that increasing the share of RC personnel in the occupations of focus is likely to produce savings for DoD and the federal government.

4. Force Readiness-Cost Relationship for Alternative Force Mix Options

Table 21 (on page 46) presented a force that could meet the maximum scale of requirements the current force could meet if it were fully ready, which is 2.22 OIF/OEFs. This readiness factor is well beyond what the current force, limited by MTF workload, can meet (0.71 OIF/OEFs), or what the force could meet with an RC expanded up to 600 percent (1.85 OIFs/OEFs). To evaluate the alternative force mix options against the current options, we need to consider comparable force readiness factors. In Figure 4 (on page 42), we plotted total cost against force readiness factor for the current force mix options. In Figure 9, we add a comparable curve for the alternative force mix options. To further facilitate comparison, we also add curves representing current force mix options with (1) a 30 percent cost premium on RC personnel, and (2) with upgraded MTF workload in addition to the premium.

Imposing a 30 percent cost premium on RC personnel shifts the original curve to the right, representing increased costs of meeting any given force readiness factor. Subsequently enhancing MTF workload shifts the curve back to the left and also straightens the curve, meaning that even large increases in the RC force do not generate diminishing returns to force readiness. Introducing alternative options (as in Section 7.D.2) in addition to the 30 percent RC cost premium and enhanced workload pushes the curve further to the left, especially for larger force readiness factors. Under the alternative options, expanding the force does not incur diminishing returns to readiness, indicated by the straightness of the curve. The horizontal distance between curves represents the difference in the costs of meeting a given force readiness factor. At a force readiness factor of approximately 1.3 or above, the alternative options are less expensive than the current options, despite accounting for the 30 percent RC cost premium. The savings due to alternative options grow quickly as the force readiness factor rises, due to diminishing returns to readiness under the current options.

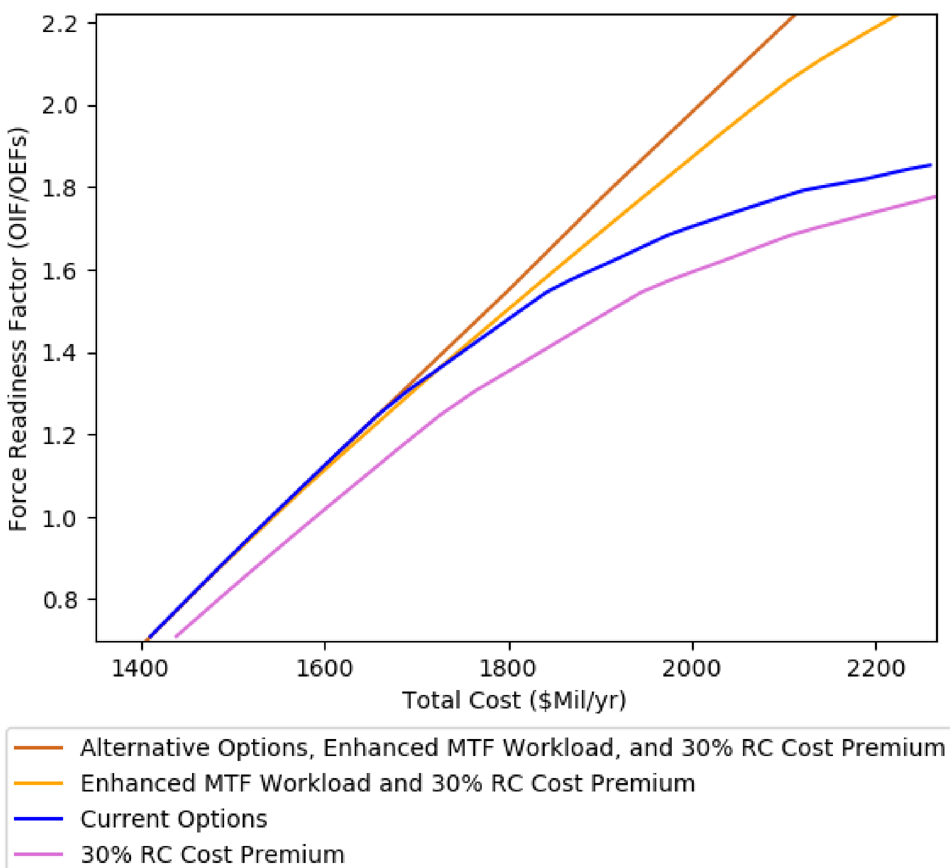

Figure 9. Force Readiness and Cost Tradeoffs under Various Specifications

The current options curve in Figure 9 assumes that all RC providers are ready. The purpose of instituting a 30 percent cost premium on RC is to guarantee that these providers are ready through stricter contract terms and monitoring regarding clinical proficiency. Therefore, comparing the current options with a 30 percent cost premium (the rightmost curve in Figure 9) to the optimal force under the alternative options provides an "apples-to-apples" comparison of forces at a guaranteed level of readiness. The difference in cost between these two forces represents the value of transitioning from the current two force mix options (AC providers in the current MHS and RC providers) to an expanded set of force mix options (AC providers in an enhanced MHS, AC providers in civilian facilities that pay half their civilian cost, operational RC providers, and strategic RC providers). For example, we estimate the cost of guaranteeing a force readiness factor of 1.56 under the current options to be $1.96 billion per year, compared to $1.80 billion per year under the alternative options, for an annual savings of $160 million, or 8.2 percent. The savings increase with the force readiness factor, which is evident from Figure 9 as the distance between the curves increases as they move up and to the right. At a force readiness factor of 1.77, we estimate savings of $326 million, or 14.4 percent.

To obtain each point plotted in Figure 9, we take as given a specific set of deployment demands, calculate the least expensive force that can meet those demands, and calculate the cost of that force meeting exactly those demands. Unlike our given set, actual future deployment demands are uncertain. A force built to meet demands 2.22 times those of OIF/OEF may actually face greater or lesser demands. Lesser demands will be satisfied by fewer deployments, which will reduce cost. Therefore, the actual cost of the force depends on future demands, which are unknowable. However, the cost of operating a force without deploying any personnel, the "peacetime cost," is a knowable lower bound on the cost of that force. In Figure 10, we depict peacetime costs for the same specifications as in Figure 9. Each point in the figure depicts the cost of operating a force that was built to meet a given force readiness factor, but then faced no deployment demands.

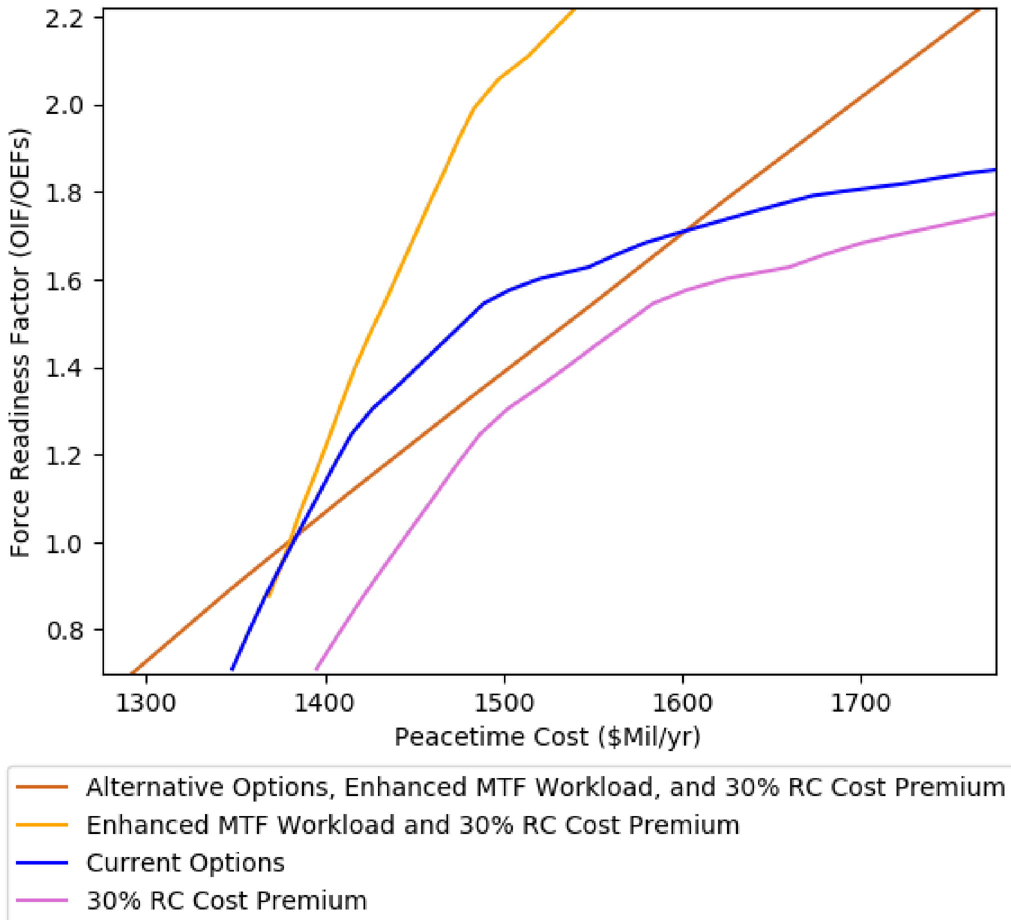

Figure 10. Force Readiness and Peacetime Cost under Various Specifications

As in Figure 9, we see diminishing marginal gains to force readiness under the current force mix options. With enhanced MTF workload, the force can reach higher readiness before the gains begin to diminish. With alternative options, the force can reach a readiness factor of 2.22 times OIF/OEF without experiencing any diminishing marginal gains. An interesting result, however, occurs between force readiness factors 1.0 and 1.7. In that range, the alternative force mix is more expensive than the current force. This is because the optimization was for a force at war, not peace.[74] During peacetime, stationing AC providers in civilian facilities is more costly than maintaining more Reservists. In other words, RC providers represent greater savings than AC providers in the event that actual requirements are less than expected. If, instead of assuming a wartime scenario, the analyses in sections 7.D.2 and 7.D.3 had been conducted over a mixed scenario of peacetime and wartime, the optimal force mixes would have relied more on the Reserves.

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[74] While the increased cost of the alternative force mix is also driven by the 30 percent RC cost premium, Figure 9 shows that the premium alone does not cause the alternative force mix to be more expensive than the current force.

8. Conclusions and Recommendations

Based on these analyses, the IDA team found that:

- The medical force currently faces readiness challenges and cannot support the scale of operations that the size of the force would suggest;
- Military-to-civilian conversion opportunities are broader than has been previously assessed and can be implemented without reducing readiness when the position targeted for conversion was not providing readiness-related workload and, thus, not maintaining the clinical readiness of the individual in the position;
- It would be very costly and, at higher levels, infeasible to be ready for larger scale operations with current medical force mix options; and
- Expanding the range of force mix options can achieve a given level of readiness at lower cost.

Based on these findings, the IDA team developed the following policy-level recommendations for consideration by USD(P&R):

- DoD should measure and report the individual (and team) clinical readiness of medical forces.
- DoD should convert military positions that are not associated with performing readiness-related workload to civilian positions (or realign facilities to eliminate positions).
- DoD should expand the readiness-related workload available to AC military personnel.
- DoD should increase the use of RC for provisions of critical wartime medical specialties.

To identify challenges that may arise in implementing these recommendations, the IDA team reviewed existing literature on medical force mix, conducted interviews with force planners and managers, and submitted a formal request to the Services for comment. See Appendix D for the request submitted to the Services.

Based on this assessment, IDA identified the following implementation challenges with the policy-level recommendations:

- Measure clinical readiness: This issue was addressed extensively in previous IDA[75] and CNA[76] publications. We did not do any additional analysis on implementation challenges for this report and, instead, relied on the previous work for the high-level implementation recommendations below.
- Convert positions: Implementation challenges for conversions and recommendations for overcoming these challenges are well documented in the previous IDA medical total force report.[77] We relied on this work and interviews with the Services for the implementation recommendations below.
- In the previous work, the importance of force management decision makers having direct transparency and authority for force mix options was emphasized to ensure trades can be identified and made. A challenge related to this raised in the course of conducting the current research was the alignment of medical position authorizations to the Defense Health Program (DHP) instead of the Services. Some Services reported resistance from the DHP to allowing the Services to make efficient conversion decisions. If medical positions are maintained to have a ready medical force for deployment, control over those positions should reside with the entity (i.e., the Service) responsible for organizing, training, and equipping the force for deployment. This is addressed in the implementation recommendations below.
- Expand readiness-related workload for AC forces: Like the above two, this issue was addressed extensively in previous IDA work[78] and the implementation recommendations below relied primarily on this earlier work.
- Increase use of RC: This was the primary focus of new analysis in the current study and the formal request to the Services in Appendix D. Key challenges identified in our interviews and Service responses include:
  – The standard Reserve arrangement (one weekend a month and two weeks a year) is poorly suited for high-skill medical professionals. These responsibilities are costly for medical professionals (e.g., high opportunity cost from impact on private practice) and they are generally not efficiently utilized during these periods (e.g., they perform medical administrative

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75 Whitley et al., "Essential Medical Capabilities"; and Lurie et al., "Medical Readiness."

76 Brevig et al., "The Quality-Volume Relationship."

77 Whitley et al., "Medical Total Force Management."

78 Lurie et al., "Medical Readiness."

work, routine medical care for Reservists, and backfill low-volume MTFs). The individuals DoD needs to recruit (e.g., high-skill trauma surgeons and emergency medicine physicians) have a high opportunity cost of time and are primarily motivated to join the Reserves to "take their jobs to the next level of difficulty and experience" (to quote one person interviewed). Imposing high-cost, low-value bureaucratic requirements as a condition for Reserve duty reduces the ability to recruit and maintain Reserve medical forces. A Reserve medical arrangement should be developed that only requires value-added duty performance and focuses those activations on mission delivery.[79]

  - There is a great disparity in recruitment effort for AC versus RC medical personnel. DoD may spend over $1.5 million on an AC physician accession (e.g., fully funded medical school, residency, and fellowship), but attempts to recruit RC physicians with only a few thousand dollars. Effective recruitment and retention of RC medical personnel will require an increased level of effort on RC force management.
  - Current Reserve arrangements are unrelated to civilian employment. For medical forces, civilian employment is the key venue for readiness training. Reserve contracts may need to be modified to ensure that civilian employment is related to duty occupation and contributing to clinical readiness.

Based on the above assessments, the IDA team developed the following implementation-level recommendations for consideration by USD(P&R):

- Measure clinical readiness:
  - ASD(R) should expand DRRS to include clinical readiness as an element of individual readiness for medical personnel.
  - ASD(R) should work with the Military Departments to develop the appropriate measures for use in DRRS. The Air Force Medical Readiness Decision Support System (MRDSS) could serve as a model for this development.
- Convert positions:

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[79] See Bipartisan Policy Center, *Building a F.A.S.T. Force: A Flexible Personnel System for a Modern Military - Recommendations from the Task Force on Defense Personnel* (Washington, DC: Bipartisan Policy Center, March 2017), https://bipartisanpolicy.org/wp-content/uploads/2017/03/BPC-Defense-Building-A-FAST-Force.pdf, for additional discussion of this issue, as well as Recommendation T-7 in that report.

- ASD(M&RA) should form a team drawn from Military Personnel Policy, Civilian Personnel Policy, TFM&RS, and the office of the Assistant Secretary of Defense for Health Affairs (ASD(HA)) to support the Military Departments with medical military-to-civilian planning and implementation. This team should identify long-standing conversion implementation challenges (e.g., the disparity in recruitment effort for military (higher) versus civilian (lower) personnel) and develop integrated solutions to support Service total force management.
- This group should work with CAPE and the Office of the Under Secretary of Defense (Comptroller) to establish a streamlined costing and MOA process for medical conversions and a policy that ensures Military Departments are able to retain the savings from conversions.
- Based on the work of this group, ASD(M&RA), in coordination with ASD(HA), should issue guidance to the Military Departments for identifying and prioritizing medical conversions. This guidance should include integration of conversion decisions into facility realignment changes such as those directed by section 702 of the FY17 NDAA as well (e.g., when positions can be eliminated instead of converted because of facility downsizing or closure). This guidance may also include conversions justified for reasons in addition to lack of readiness workload and not fulfilling deployable requirements, e.g., positions solely supporting career pyramid considerations.
- USD(P&R) and CAPE, working with the Military Departments, should develop and execute a process for returning the authorizations of military medical personnel from the Defense Health Program to the Services.

- Expand readiness-related workload for AC forces:
  - USD(P&R) and CAPE should direct the Defense Health Agency and Military Departments to establish military-to-civilian partnerships between MTFs and civilian trauma centers, as identified in the recent IDA report completed for CAPE and directed in the FY17 NDAA, to bring additional readiness-related workload into the MTFs.
  - USD(P&R) and CAPE should direct the Military Departments to establish military-to-civilian partnerships between the Services and civilian trauma centers to place military medical personnel in civilian facilities with readiness-related workload.

- Increase use of RC:
  - The Deputy Assistant Secretary of Defense for Reserve Integration (DASD(RI)), in coordination with the National Guard Bureau (NGB) and the Service Reserve commands, should conduct a survey and focused interviews with current and potential Reserve medical personnel to identify issues that currently prevent successful Reserve recruitment, e.g., the requirement to participate in arbitrarily determined weekend and summer drills that are disruptive to their private practice and involve performing administrative and routine clinical duties instead of creating less disruptive opportunities throughout the year to engage in mission-oriented operational activities.
  - DASD(RI), in coordination with the NGB and Service Reserve commands, should use the survey and interview information to develop policy reforms and, if necessary, legislative change proposals, to create Reserve options better aligned to meet medical requirements and more suitable to medical professionals.
  - Upon completion of the DASD(RI) assessment, USD(P&R) and CAPE should issue guidance to the Services identifying and prioritizing realignment of the medical force from AC to RC performance.

9. Nursing Force Excursion

Most of this report has been focused on the challenges with maintaining a clinically ready medical force. There are other challenges with the medical force, however, that involve force mix decisions. One of these other challenges is that the medical force is primarily focused on highly technical skilled tasks (e.g., trauma surgery) and not strategic combat leadership, while the military force management system (e.g., little lateral entry and required up-or-out career paths) is focused on growing leaders for progressively larger roles in combat leadership. In civilian practice, typical physicians, nurses, and other medical professionals spend most, if not all, of their careers in clinical practice. But in the military, higher pay and continued service are tied to promotions into leadership positions.

This mismatch of force management practice for high human capital practitioner-oriented professions is widely recognized, but there has been little development of the challenges specific to the medical force. TFM&RS asked IDA to, as a research excursion, begin examining this challenge in the context of the medical force. This excursion was not the main focus of the analysis and does not comprehensively address the issue. This chapter presents the preliminary analysis conducted for the excursion and identifies next steps for more comprehensively addressing this challenge.

The management of the military nursing force is an example of this challenge. Civilian best practice typically involves nurses working in a clinical setting most of their careers. Current DoD force management policies, however, make this impossible because an individual's ability to stay in military service is tied to length of service, rank, and promotions. This creates a situation in which nurses must leave clinical practice, and progressively expanding leadership positions must be created for Nurse Corps officers to maintain promotion pathways. The concern is that these created positions do not fully employ the clinical education and training nurses possess. The ultimate goal of this analysis (not achieved in this preliminary excursion) is to identify this "overhead" cost (i.e., higher ranked positions created to support lower ranks) of maintaining military nursing positions.

This chapter describes the civilian nursing workforce and begins a comparison of that to the military nursing workforce in the areas of career paths, career length, workload type, workforce organization, and staffing. The excursion uses three approaches to analyzing these issues. First, we conduct a review of the literature. Second, we conduct interviews with Subject Matter Experts (SMEs). Third, we perform a descriptive analysis of the nursing workforce.

A. Background

The Defense Officer Personnel Management Act of 1980 (DOPMA) is the main public law governing officer personnel management. DOPMA regulates the number of officers relative to end strength through promotion probability guidelines and years of service guidelines for promotions. Specifically, the law sets limits on the number of O4–O6 officers relative to the number of O1–O6 officers; the desired effect is for the officer corps to become more senior as end strength falls and vice versa. This law and other detailed statutes have resulted in (1) an officer corps rank pyramid where the number of positions at each increasing grade becomes smaller and smaller, and (2) a competitive, "up-or-out" system. If an officer is not able to be promoted to the next level of the rank pyramid, they must retire.

Unlike the Medical and Dental Corps, the promotion decisions of the Nurse Corps are governed by the guidelines laid out in DOPMA. The Medical and Dental Corps are exempt from grade limitations in all grades up to O6 because "of the unique problems of obtaining and retaining physicians and dentists"; doctors and dentists are eligible for "accelerated promotion as a retention incentive."[80] Under DOPMA, the Nurse Corps are their own separate competitive category. A competitive category is a grouping of officers who compete among themselves for promotion.

B. The Civilian Nursing Workforce

The civilian nursing workforce consists of certified nursing aides/assistants (CNAs), licensed practical nurses (LPNs), and registered nurses (RNs). The first sub-section provides a description of the education, training, and responsibilities for each type of nursing care provider, while the second sub-section focuses on describing the RN career paths. A third sub-section discusses workforce organization.

1. Education, Training, and Responsibilities

Certified Nursing Assistants: CNAs typically perform the most basic nursing care in nursing care facilities and patient homes under supervision. For example, their core responsibilities include bathing and dressing patients, taking vital signs, turning bedridden patients, providing and emptying bedpans, serving meals, and helping patients eat. According to discussions with SMEs, nursing assistants are the second most common type of nursing care providers (after RNs) in hospital settings.

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[80] Mary T. Sarnecky, *A Contemporary History of the US Army Nurse Corps* (Washington, DC: The Borden Institute, April 2010).

Job training usually consists of up to 75 hours of training resulting in a postsecondary non-degree certificate or diploma; a college degree is not required.[81] Additionally, CNAs are required to pass a competency exam for the state in which they practice.

Licensed Practical Nurses: LPNs are most commonly found providing basic medical and nursing care in long-term care facilities, clinics, and outpatient facilities under the supervision of an RN or physician. For example, their core responsibilities include recording medical histories, immunization and medication administration, and data entry. According to discussions with SMEs, LPNs are used less often in hospital settings; however, the literature reports that LPNs do appear in greater numbers in for-profit and government hospitals where cost efficiencies may be more pronounced because LPNs can substitute for RNs.[82]

Similar to CNAs, LPNs are not required to have college degrees. Unlike CNAs, LPNs have a substantially longer training time—12 to 18 months—resulting in a postsecondary non-degree practical certificate or diploma.[83] If an LPN decides to become an RN in the future, their LPN training can count as credit toward the degree. Additionally, LPNs are required to pass the NCLEX-PN exam to be licensed.

Registered Nurses: RNs can be found in all types of health settings. According to discussions with SMEs, RNs are the most common type of nursing care providers in hospital settings. The RN Work Project, a national study tracking career changes among new nurses from 2006 to 2016, states that for 88.3 percent of RNs, their first job is in a hospital setting.[84] The responsibilities of RNs differ significantly from those of CNAs and LPNs; they include medication and treatment administration, documentation, coordination of patient care plans, performance of diagnostic tests and analysis of results, instruction of patients on how to manage illnesses after treatment, and supervision of CNAs and LPNs.[85]

RNs work in a diverse range of roles: staff nurses, educators, administrators, health system executives, clinical leaders, and as advanced practice registered nurses (APRNs), a group that includes nurse practitioners (NPs), clinical nurse specialists (CNSs), certified

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81 Institute of Medicine (IOM), *Future of Nursing: Leading Change, Advancing Health* (Washington, DC: National Academies Press, 2011), http://hdl.voced.edu.au/10707/249309.

82 Jean Ann Seago, Joanne Spetz, Susan A. Chapman, and Wendy Dyer, *Supply, Demand, and Use of Licensed Practical Nurses* (Washington, DC: Health Resources & Services Administration, US Department of Health & Human Services, November 2004).

83 IOM, *Future of Nursing.*

84 RN Work Project, http://www.rnworkproject.org/.

85 "Registered Nurse vs. Licensed Practical Nurse," All Nursing Schools, http://www.allnursingschools.com/nursing-careers/article/registered-nurse-vs-licensed-practical-nurse/.

registered nurse anesthetists (CRNAs), and certified nurse midwives (CNMs). The common characteristic shared by all RNs is possession of a two- to three-year associate's degree in nursing (ADN) or a four-year Bachelor of Science degree in nursing (BSN). The BSN is considered the gold standard of nursing education.[86] In addition, all RNs have to pass the NCLEX-RN exam for licensure. It is common for RNs to pursue advanced education resulting in a two-year master's degree in nursing (MSN or MS). The Institute of Medicine (IOM)'s 2011 *Future of Nursing* report finds 13 percent of nurses hold a graduate degree (excluding doctoral degrees).[87] Similarly, the 2015 National Nursing Workforce Survey reports 13.6 percent of nurses indicate MSN as their highest level of education. Interestingly, when respondents in this group were asked to report their position title, 46 percent were employed as APRNs, 17 percent as staff nurses, 9 percent as nurse faculty, and 9 percent as nurse managers.[88] A smaller number of RNs pursue a doctor of philosophy (PhD) degree or a doctor of nursing practice (DNP) degree.[89] The IOM report finds that less than 1 percent of nurses overall hold a doctoral degree in nursing or a nursing-related field, while the 2015 National Nursing Workforce Survey reports that 2.2 percent of nurses overall indicate a PhD or DNP as their highest level of education.

2. RN Career Paths

Through discussions with SMEs and reviews of national studies on the nursing workforce, we identified four main career paths for civilian RNs. These paths primarily begin with the provision of direct, or bedside, care as illustrated in Table 23, which presents preliminary results from the RN Work Project. It should be noted that this study followed the same nurse cohort over a number of years. According to the RN Work Project, 93.1 percent of the survey respondents report direct care as their job six to eight months after licensure.[90] Table 24 presents results from the National Council of State Boards of Nursing and the National Forum of State Nursing Workforce Centers' 2015 National Nursing Workforce Survey, the only national-level survey specifically focused on the US nursing workforce. Specifically, it shows the proportion of RNs in a certain job for each age group. For example, 10 percent of RNs between the ages of 30 and 34 are

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86 Grace Eileen Scrimgeour, "Who Cares? The Role of Nursing Assistants in the Labor Process of Hospital Nursing" (dissertation, Loyola University, 2015), http://ecommons.luc.edu/cgi /viewcontent.cgi?article=2491&context=luc_diss.

87 IOM, *Future of Nursing*.

88 Ibid.

89 Ibid.

90 "Longitudinal Comparison of Early Career Nurses' Employment Trends," RN Work Project, 2011, http://www.rnworkproject.org/wp-content/uploads/Employment-Trends-COLOR-for-WEB-v2-04.13.11nms.pdf.

APRNs. It should be noted that the survey does not follow the same cohort over an entire career. This survey just takes an annual snapshot of the entire nurse workforce. Thus, the data might be confounded by individuals who start a nursing career in their later years, but there are no studies that follow a single cohort of nurses for an entire career.

Table 23. RN Job Type in Early Years of Career

Months Post Licensure	Direct Care	Manager (Charge Nurse and Higher)	Advanced Practice Nurse	Other (Consultant, Research, Educators)
6-18	93.1%	2.4%	0.4%	4.1%
19-30	87.3%	5.3%	0.9%	6.2%
31-54	71.3%	16.9%	1.9%	8.9%

Source: RN Work Project.

Table 24. RN Job Type by Age Group

Primary Position Title	Age								
	Younger than 30	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65 and Older
Advanced practice nurse	4%	10%	10%	10%	8%	7%	7%	8%	9%
Case manager	3%	4%	5%	6%	8%	7%	9%	9%	8%
Clinical nurse leader	2%	3%	4%	4%	4%	5%	5%	5%	4%
Consultant	0%	1%	1%	1%	2%	2%	2%	3%	5%
Nurse executive	0%	1%	1%	2%	3%	3%	3%	5%	4%
Nurse manager	3%	6%	7%	10%	8%	10%	9%	10%	9%
Nurse faculty	3%	4%	3%	3%	3%	3%	4%	5%	6%
Nurse researcher	0%	0%	0%	1%	1%	1%	1%	1%	1%
Other – health related	1%	2%	5%	5%	6%	7%	8%	8%	9%
Other – not health related	0%	1%	1%	1%	0%	1%	1%	1%	1%
Staff nurse	83%	69%	62%	57%	57%	53%	51%	47%	45%

Source: National Council of State Boards of Nursing and the National Forum of State Nursing Workforce Centers' 2015 National Nursing Workforce Survey.

The first path, which appears to be the most common, is to continue working as a staff nurse for the bulk of the career. The second path is to pursue graduate studies and then move into a career as an APRN. A third path is to move into a managerial or administrative role. A fourth path, which appears to be the least frequently pursued, is to complete graduate studies and then move into an academic or research role. In recent years, a growing new job sector, care coordination, has appeared, although it remains to be seen if these new jobs (i.e., case manager or clinical nurse leader) are merely another step in the previously mentioned career paths or if they should be considered as entirely different. According to one SME, the number of nurses leaving the profession is low; she estimates it to be 5 percent or less.[91] The following sections describe each of the four aforementioned career paths in greater detail.

a. Bedside

It appears the majority of RNs spend their careers at the bedside. The 2015 National Nursing Workforce Survey finds that 58 percent of respondents report their primary position title as staff nurse. The survey also breaks this number out by nine age groups; the proportion of RNs who work as staff nurses declines in each subsequent age group, from 83 percent of RNs under the age of 30 to 45 percent of RNs 65 and over. This is consistent with the findings from the RN Work Project, which reports that 31 to 54 months after licensure, 71.3 percent of RNs continue to work as staff nurses or charge nurses. Unfortunately, there are no data beyond this point, but one SME believed at least 50 percent of RNs continue to work as staff nurses 10 years post licensure, while another SME found that 30 to 40 percent—and as high as 50 percent—of RNs remain bedside.[92]

b. Advanced Practice

After working at the bedside for some time, some RNs pursue MSN degrees to become APRNs—a group that includes NPs, CNSs, CRNAs, and CNMs. RNs in this group are still providing clinical care. From six to eight months post-licensure to 31 to 54 months post-licensure, the RN Work Project finds the proportion of survey respondents possessing the job title of APRN to increase from 0.4 percent to 1.9 percent. Although the data do not extend beyond 54 months, other sources suggest that a not insignificant proportion of nurses pursue this path. The 2015 National Nursing Workforce Survey reports 8 percent of all nurses state their primary position title as APRN. The gap between the RN Work Project finding and 2015 National Nursing Workforce Survey finding hints at the length of time between an RN receiving their initial nursing education

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[91] Christine Kovner (investigator on RN Work Project), interview with Linda Wu, August 24, 2016.

[92] Joanne Spetz (director of the Center for Nursing Workforce, University of California, San Francisco), interview with Linda Wu, August 29, 2016; and Christine Kovner, interview with Linda Wu, August 24, 2016.

and their return for further education. The survey finds a jump in the number of RNs holding APRN positions between those under the age of 30 and those between ages 30 and 34 from 4 percent to 10 percent. After the age of 34, the proportion of APRNs in each group remains steady until the age group of 65 and older.

c. Management/Administration

The third career path is movement into a management or administrative position, such as nurse manager/head nurse, director of nursing services, house supervisor, or chief nursing officer/chief nurse executive (CNO/CNE).[93] The typical job responsibilities include overseeing other nurses and completing administrative duties such as evaluating and implementing nursing policy, meeting regulatory and compliance requirements, coordinating with staff, and ensuring standards of care are met. These job responsibilities likely involve a significantly reduced focus on providing direct patient care, but that may also depend on the specific positions (e.g., the head nurse on a ward in a hospital is likely more directly involved in patient care than a chief nurse executive). These positions may require an individual to pursue graduate education in fields such as health services administration, public health, or business administration.

Some surveys consider the position of charge nurse a management position while other surveys do not. Charge nurses are described as shift managers, responsible for managing the day-to-day clinical patient care on a specific shift and unit in addition to their direct patient care workload. Several staff nurses may rotate this responsibility on each shift. Charge nurses report to the nurse manager, who is responsible for managing the operations of one or several units, including the hiring and firing of personnel and the scheduling of teams. A nurse manager reports to a director of nursing services, who in turn reports to the CNO/CNE.[94] For the purpose of this paper, we consider charge nurses to be clinical care providers if it is possible to distinguish them from other management positions.

According to the RN Work Project data, the proportion of respondents who move into the title of manager increased from 2.4 percent to 16.9 percent in 4.5 years. This number includes charge nurses. The 2015 National Nursing Workforce Survey reports 10 percent of all RNs have position titles of either nurse executive (2 percent) or nurse manager (8 percent). The same survey finds that the proportion of RNs that are nurse executives is 1 percent for ages 30–39, doubles to 2 percent for ages 40–44, and increases to 3 percent for ages 45–59 and to 5 percent for ages 60–64. The proportion of RNs who are nurse managers doubles from 3 percent to 6 percent at the age of 30 and increases

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93 "Who's Who in the Nursing Hierarchy," Monster.com, http://nursinglink.monster.com/education /articles/21602-whos-who-in-the-nursing-hierarchy?page=1.

94 Ibid.

steadily to 10 percent until the age of 40; after that, the proportion of RNs who are nurse managers holds steady.

d. Academic/Research

The fourth career path is movement into an academic or research role. The RN Work Project reports the proportion of respondents who move into “other” roles increasing from 4.1 percent to 8.9 percent in 4.5 years. Note that this “other” category includes more than simply nurse educators and researchers; it also includes nurse consultants. One SME states that 1 percent of RNs go into academia or research, although the 2015 National Nursing Workforce Survey reports 4 percent of RNs work as nurse faculty and 1 percent work as nurse researchers.

These jobs may require further educational credentialing, such as an MSN, PhD, or DNP degree. Of the RNs who report working as nurse faculty in the 2015 National Nursing Workforce Survey, over half possess an MSN (35.8 percent) or higher (17.7 percent) degree. Of the RNs who report working as nurse researchers, nearly 70 percent possess a BSN (37.5 percent) or higher (30.2 percent) degree.

Overall, the literature and SMEs interviews indicate that the majority of RNs provide clinical care throughout their careers. The majority of nurses (RNs or otherwise) are not in management, academia, or research.

3. Workforce Organization and Management

a. Use of LPNs/CNAs

The nursing workforce in a typical hospital setting is made up of RNs and CNAs; RNs make up 30 percent of total employees in hospitals and aides make up 8 percent.[95] Use of LPNs in hospital settings has declined significantly over recent decades. Currently, LPNs are more commonly found in clinics and outpatient settings.

The declining use of LPNs in hospital settings and the need for a flexible workforce to reduce costs are factors driving an increased demand for highly trained CNAs who can fill a variety of roles in addition to their core responsibility of providing basic nursing care.[96] One SME, a former Nurse Executive with experience working in several large academic health systems, spoke about a new trend of augmenting the RN staff with highly trained technical employees. Specifically, the SME said that there is an emphasis

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[95] General Accounting Office, Statement of William J. Scanlon, Director, Health Care Issues, Testimony Before the Committee on Health, Education, Labor and Pensions, US Senate, “Nursing Workforce: Recruitment and Retention of Nurses and Nurse Aides Is a Growing Concern,” GAO-01-750T, May 2001, https://files.eric.ed.gov/fulltext/ED454422.pdf.

[96] Scrimgeour, “Who Cares?”

on using the RN's education and training (e.g., in patient teaching, patient assessment, and patient discharge) to the greatest extent possible by training CNAs to carry out the more technical and basic tasks. This reflects the trend of nursing becoming more professionalized, improved in status, and more technical and supervisory. In the health systems in which the SME has worked, CNAs go through the health systems' own training programs.

b. Ratio of Clinical Personnel to Non-Clinical Personnel

In order to evaluate this ratio for the civilian sector, it is necessary to classify each position type in Table 24 as to whether or not it mainly involves the provision of clinical care to patients. Available information on RN positions summarized above suggests that staff nurses and APRNs spend the majority of their worktime providing clinical care to patients, and those categorized as consultants, nurse executives, nurse faculty, nurse researchers, "other – health related," and "other – not health related" do not. It is also assumed here that case managers, clinical nurse leaders, and nurse managers also do not spend the majority of their time providing clinical care. These RN positions involve a mix of clinical care and managerial activities, and it may be that the clinical care component is significant, but these positions are treated as primarily managerial in nature in order to be conservative when using the civilian sector as a comparator benchmark for military nurses.

The ratio of clinical-provider RNs to total RNs is 87 percent for the youngest age group (18–30 years old) and falls with age, but even for the oldest age group (> 65 years old), it is still over half of all RNs (54 percent). A majority of civilian-sector RNs are thus dedicated primarily to providing clinical care at all ages.

One limitation in using these data to understand best practice benchmarks for comparison with DoD is that they cover the entire nursing profession and not the makeup of the nursing workforce for a large delivery system (which DoD replicates during both peacetime—for beneficiary healthcare, and wartime—for deployment healthcare). Further analysis should be conducted to understand if the workforce of large hospitals and, perhaps more interestingly, large integrated delivery systems that include both inpatient and outpatient care delivery have a similar distribution of their nursing workforce.

c. Nurse Staffing

In 2004, California became the first state to implement minimum nurse-to-patient staffing ratios. California mandated the following nurse-to-patient staffing ratios:

- 6:1 patient-to-nurse workload in psychiatrics;
- 5:1 patient-to-nurse in medical-surgical units, telemetry, and oncology;

- 4:1 in pediatrics;
- 3:1 in labor and delivery; and
- 2:1 in intensive care units.

These ratios are not universally accepted. In our discussions with SMEs and our review of the literature, there does not appear to be a commonly agreed upon set of nurse-to-patient staffing ratios or guidelines for determining the most efficient staffing mix given the number of patients. Civilian hospitals use patient acuity systems to determine the appropriate staffing. These patient acuity systems rank the level of sickness of the patient population and from this, nurse administrators and managers determine the number of nurses to care for a certain patient population.

d. Recruitment and Retention Issues

In the civilian nursing sector, it does not appear that administrative and management promotions are commonly used as recruitment and retention incentives.

C. The Military Nursing Workforce

The military nursing workforce also consists of CNAs, LPNs, and RNs who can either be military, civilian or contractor. There are slight differences in the way each Service organizes its nursing care providers. The next section discusses these differences and the following section presents the typical career path of an Army nurse officer, which is representative of the experiences of nurse officers in the other Services.

1. Education, Training, and Responsibilities

Certified Nursing Assistants and Licensed Practical Nurses: In the military, both CNAs and LPNs are enlisted personnel. In the Army, there is a direct military equivalent of LPNs—Army Military Occupational Specialty (MOS) 68W(M6)/68C for practical nursing specialists. The Army can also map these individuals directly to the DoD occupation of licensed practical nurse. However, there are no clear military equivalents (i.e., no Army MOS, Navy Enlisted Classification Codes (NECs), Air Force Specialty Codes (AFSCs) or DoD occupation codes) for CNAs for all Services and for LPNs for the Navy and Air Force. Therefore, it is not clear from aggregate data how many military CNAs and LPNs there are.

In the Army, CNAs fall under the Army MOS 68W—combat medic specialists, who are the first tier of the Army medical system. There is no direct mapping to a DoD occupation of nursing assistant or certified nursing assistant. Instead, the 68W combat medic career track is an umbrella for numerous duty specializations that map to multiple DoD occupation codes, such as Medical Care and Treatment, General; Operating Room Services; or Orthopedic Services.

Both the Navy and Air Force include CNAs and LPNs in the general enlisted groups of hospital corpsmen (NEC HM)[97] and aerospace medical service specialists (AFSC 4N0X1).[98] Similarly to the Army combat medic career track, the Navy corpsman and Air Force medical service specialist career tracks are umbrellas for numerous duty specializations that map to multiple DoD occupation codes. For example, the Navy's HM NEC is the only enlisted medical rating in the Navy, and this varied group includes CNAs, LPNs, dental assistants, and medical laboratory technicians.

This makes it difficult to identify the number of enlisted CNAs and LPNs in the military from the aggregate data the IDA team used for this paper, which is an important factor in understanding the provision of nursing care in the military.

Army LPNs participate in a program approved by the Texas Board of Nursing and receive LPN licensure in Texas. The initial training for Army combat medics is closely aligned with emergency medical technician (EMT) training, while the initial training for Navy corpsmen and Air Force medical service specialists is closely aligned with both EMT training and LPN training. Some personnel receive additional specialty training.[99]

Registered Nurses: RNs join the military as officers. In contrast to the civilian sector, the military requires all Active Duty nurse officers to hold, at a minimum, a BSN degree. The Reserve Component, similar to the civilian sector, accepts applicants with either an ADN or BSN degree. Both components require RNs to pass the NCLEX-RN exam.

Once nurses graduate, receive their commission, and pass the NCLEX-RN exam, the military sends their new nurses through transition and residency programs in addition to a typical 2.5-month Basic Officer Leaders Course (BOLC). The Army operates the six-month Clinical Nurse Transition Program (CNTP) while the Air Force operates the one-year and 45 days Nurse Transition and Residency (NTR) program. These relatively new training programs were created in response to a 2010 IOM report recommending that nurses should have the benefit of residency training.[100] These training programs have no civilian analogue. In CNTP, a nurse officer is paired with a more experienced health care

97 "Learn about Being a Navy Hospital Corpsman," The Balance, https://www.thebalance.com/career-profile-navy-hospital-corpsman-2356481.

98 "Career Profile: Air Force Aerospace Medical Services," The Balance, https://www.thebalance.com/career-profile-air-force-aerospace-medical-services-2356428.

99 "Licensed Practical Nurses, Registered Nurses," National Governors Association, https://www.nga.org/files/live/sites/NGA/files/pdf/2013/1311VeteransPolicyAcademy-OMOS.pdf.

100 Kevin M. Hymel, "Transition and Residency Programs Create Professional AFMS Nurses," November 23, 2015, Air Force Medical Service Media Center, http://www.airforcemedicine.af.mil/News/Article/630880/transition-and-residency-programs-create-professional-afms-nurses/.

provider (i.e., preceptor). The preceptor orients the officer to the clinical area and assists the officer with the transition into the military environment.[101]

According to one SME, the military expects nurse officers to fill leadership roles, and as such, nurse officers receive additional training and responsibilities separate from clinical training and duties.

2. RN Career Paths

According to information provided on the Northern Michigan University website,[102] after finishing the residency programs, nurse officers begin their careers as clinical staff nurses in general medical-surgical wards. As a member of a treatment team, a clinical staff nurse is primarily focused on direct patient care. This phase in their nursing career usually lasts a year.

After working as a staff nurse, a nurse officer either becomes a charge nurse or is selected to attend a nurse specialty school and, after completion, transferred to a unit of their specialty. As a charge nurse, the nurse officer, who is now a first lieutenant, is typically given some management responsibilities. For example, the nurse officer may be responsible for staff/patient care assignments and the overall operations of the patient care ward. This role is comparable to that of a platoon leader. This phase in their nursing career usually lasts two or three years.

If a nurse officer is promoted to the rank of captain, there are various different paths they can take. A nurse officer can apply for graduate studies or specialty training, or they can serve as a head nurse, in a staff officer role, as an educator, or in administration. As a head nurse, the nurse officer is responsible for all actions in their ward. This includes logistics, staff and budget management, training requirements, and patient care quality. An Army nurse officer may hold the position of head nurse for one to three years.[103] This role is comparable to that of a company commander. For the Army Nurse Corps, an individual can become a head nurse after three years, but most hold the position between five and seven years. In other career paths, an Army nurse officer may work in nonclinical environments such as research institutes or government agencies. For example, they may work as a nurse counselor within Cadet Command or as a healthcare recruiter within Recruiting Command.

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[101] "Your Career in Army Nursing after College," Northern Michigan University, https://www.nmu.edu /militaryscience/your-career-army-nursing-after-college.

[102] Ibid.

[103] "FAQ: Army Nurse Corps Frequently Asked Questions," University of Toledo, http://www.utoledo.edu/rotc/pdfs/nursing_faq.pdf.

After attaining the rank of lieutenant colonel or colonel, nurse officers are eligible to serve as clinical section supervisors, assistant chief nurse and chief nurse of hospitals, hospital command positions, and special staff officers.

In summary, after serving as a staff nurse for a year, a nurse officer's primary responsibilities may change to where they are not providing any direct patient care. In the civilian world, opportunities for professional advancement are limited, with positions usually filled by nurses with seniority within the organization. One SME confirms this and adds that while it is typical in civilian hospitals for leadership roles to only open up when the individuals in those positions retire, in military hospitals, this does not happen. Instead, individuals rotate through leadership roles (e.g., nurse managers typically stay in their jobs for three years and move on), so there are more opportunities for advancement.[104]

Table 25 shows the number of AC nurse officers by rank and age group as of September 30, 2015. The vast majority of nurse officers (89 percent) are below the age of 50, while slightly more than half (56 percent) of civilian RNs are. Roughly two-thirds (64 percent) of nurse officers hold the rank of captain or below.

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[104] Patricia Patrician (Donna Brown Banton Endowed Professor, University of Alabama at Birmingham School of Nursing), interview with Linda Wu, October 26, 2016.

Table 25. Active Component Nurse Officer Counts by Rank and Age Group, September 30, 2015

	Age Group										
Rank	**18–30**	**30–34**	**35–39**	**40–44**	**45–49**	**50–54**	**55–59**	**60–64**	**> 64**	**Total**	**Share**
O1	663	183	80	21	1	0	0	0	0	948	10.0%
O2	983	296	207	92	13	2	0	0	0	1593	16.8%
O3	707	1021	864	554	240	73	12	0	0	3471	36.7%
O4	0	136	466	642	486	241	87	8	0	2066	21.8%
O5	0	0	30	315	322	215	110	19	0	1011	10.7%
O6	0	0	0	9	125	154	55	19	0	362	3.8%
>O6	0	0	0	0	0	3	5	0	0	8	0.1%
Total	2353	1636	1647	1633	1187	688	269	46	0	9459	
Share	24.9%	17.3%	17.4%	17.3%	12.5%	7.3%	2.8%	0.5%	0.0%		100.0%

Source: DMDC personnel files. Deployed nurse officers are included in these counts.

To recruit nurse officers, DoD may pay graduate nurses college tuition and a stipend through Reserve Officer Training Corps (ROTC) programs. The commitment length for accepting an ROTC scholarship varies. The Army requires a commitment of eight years, and depending on how many years of benefits an individual takes, they have to serve on Active Duty for at least four years. If the individual chooses to leave Active Duty, they can complete the remainder of their commitment through the Reserves or National Guard.[105]

To retain nurse officers, the military offers clinical specialty training courses for nurses who want to specialize and fully funds graduate training for a select group of nurses who want to attend a master's or doctoral program. Nurses in these programs continue to receive their full salary and benefits during their studies.

3. DoD Workforce Organization and Management

The provision of nursing care in the military relies on a mix of personnel, including officer, enlisted, civilian, and contractor nurses. Table 26 gives the FTE breakdown for officer, civilian, and contractor nurses at the RN level who were attached to a fixed MTF in 2015. These values are calculated from MEPRS data.[106] Civilians and contractors thus accounted for slightly over half (57 percent) of all RN-level nurses attached to MTFs in 2015. This picture is consistent with the above statement of a SME that the provision of nursing care in the military is fundamentally different from that in the civilian sector, with different manpower types (officer, enlisted, civilian, and contractor) playing different roles in the military health system. Nurse officers fill the leadership roles but the actual provision of nursing care is primarily done by enlisted nursing providers and civilian and contractor nurses.[107]

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105 "FAQ: Army Nurse Corps Frequently Asked Questions," University of Toledo.

106 MEPRS allocates manpower and other costs to a set of accounts. Each account falls under one of seven work centers or activities, including inpatient care (A codes), ambulatory (outpatient) care (B codes), dental care (C codes), ancillary services (D codes), support services (E codes), special programs (F codes), and readiness (G codes.) MEPRS may or may not contain data for personnel working in Limited Scope Medical Treatment Facilities (LSMTFs), medical aid stations, squadron medical elements, designated functional flights, deployed mobile MTFs, occupational and environmental health laboratories, medical research and development functions, Air National Guard Medical Units, or Air Reserve Medical Units. See Air Force Instruction 41-102: "Medical Expense and Performance Reporting System (MEPRS) for Fixed Military Medical and Dental Treatment Facilities," August 5, 2016. The manpower data in MEPRS consist of labor hours. There may be inaccuracies in the data, as the data depend on the accuracy with which MTF personnel fill out their timecards that record the daily number of hours worked in each of the seven activities.

107 Patricia Patrician, interview.

Table 26. RN-Level Nurses Attached to Military Treatment Facilities in 2015

Personnel Category	Number
Officer	8,061
Civilian	8,846
Contractor	1,819

Source: calculated from MEPRS data.

A significant component of the officer nursing force is not attached to MTFs. The DMDC database shows that the total number of officer nurses in September 2015 equaled 9,321 (Table 25), of which 9,260 were not deployed to a contingency. Subtracting the 8,061 officer nurses who were attached to an MTF (Table 26) gives a residual of 1,260 nurses. Of these, 61 were deployed, so that there is a residual of 1,199 non-deployed officer nurses, or 15 percent of the non-deployed total, who were presumably attached to non-MTF units and organizations.

4. Ratio of Clinical Providers to Non-Clinical Personnel

To identify if there is an "overhead" cost of military nursing positions from force-fitting a flat civilian career path into a pyramidal military career path and, if so, the extent of that cost, one approach would be to compare the fraction of nurses providing clinical care in the military to the fractions identified above for civilian nurses. The aggregate data obtained for this study (DMDC force data and MEPRS cost accounting data from MTFs) did not allow for direct estimation of the fraction of the military nursing force providing clinical care. Some preliminary observations include:

- Civilian benchmark ratio: Looking across all ages from Table 24 and focusing on nurse job titles used by DoD, the civilian baseline is that about 70–90 percent of nurses work in clinical care provision. The range is based on whether to include case managers, clinical nurse leaders, and nurse managers as clinical care providers.
- Military ratio: Making simple assumptions based on rank and duty assignment (e.g., all O1 to O3 military nurses assigned to MTFs provide clinical care, while nurses assigned outside of MTFs and ranked O4 and above do not) produces estimates significantly lower than the civilian benchmarks.
- Military and MTF civilian ratio: The MTF workforce is composed of both military and civilian nurses, however, and it may be more appropriate to consider the entire workforce together. Making simple assumptions about this total force (e.g., all MTF civilian nurses provide clinical care while only some military nurses do, based on rank and duty assignment) produces estimates that

range from modestly below to approximately equivalent to the civilian benchmark.

D. Conclusions

It has been widely observed that force-fitting high human capital, practitioner-based careers into the military force management system likely creates “overhead” costs. Quantitatively estimating these costs within specific specialty areas will improve the ability of DoD leadership to reform force management policies and practices to more efficiently maintain forces within these specialties. This chapter has begun the process of creating these “overhead” cost estimates for military nurses, but it was beyond the scope of this simple excursion to create a complete and reliable estimate. The key next step to doing so is to obtain more granular data about the military (and civilian) DoD nursing force by age, rank, and specific function.

Appendix A.
Data Sources

We obtained from the Defense Manpower Data Center (DMDC) monthly records for all Active Component and Reserve Component personnel from October 2001 through July 2016. We used Service and DoD occupation codes to identify medical personnel and their occupations. We validated the data by comparing them to Health Manpower Personnel Data System fiscal year reports for 2001 through 2015. We also obtained from DMDC all deployment data from the Contingency Tracking System (CTS) in the same period plus September 2001, August 2016, and September 2016. Scrambled identifiers allowed the matching of personnel records to deployments. The CTS contains only deployments to named contingencies, primarily OIF and OEF in the time period studied.

Appendix B.
Medical Force Costing

In section 2.B, we presented cost estimates for Active Component (AC), Reserve Component (RC), and civilian physicians by Service for the occupations of focus in this paper. We derived the AC and civilian cost estimates from previous Institute for Defense Analyses (IDA) cost estimates.[1] These cost estimates were for Fiscal Year (FY) 2013, so we converted them to FY 2017 dollars using Service-specific inflation factors for military personnel published by the Office of the Under Secretary of Defense (Comptroller) (OUSD(C))/Chief Financial Officer.[2] To estimate RC costs, we built on other previous IDA work that estimated RC personnel costs as the sum of cost elements.[3] We began with base RC personnel cost elements specific to Service and rank, but not occupation. We then derived rank-specific average physician incentive and special pays using data from FY 2017 budget exhibits for each of the five Reserve Components. We then aggregated our RC personnel cost estimates to the Service-occupation level, weighting by the July 2016 occupation-specific rank distributions.

Table B-1 lists the elements of the cost estimates and their respective sources for both AC and RC personnel. AC cost estimates are based primarily on composite rate,[4] Office of Cost Assessment and Program Evaluation (CAPE) Full Cost of Manpower tool,[5] and Medical Readiness Review (MRR)[6] data. RC costs are based primarily on Defense Finance & Accounting Service (DFAS), Future Years Defense Program (FYDP), and component budget data.[7] All costs are converted to FY 2017 dollars.

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1 John E. Whitley et al., "Medical Total Force Management," IDA Paper P-5047 (Alexandria, VA: Institute for Defense Analyses, May 2014).

2 OUSD(C), "National Defense Budget Estimates for FY 2017," March 2016, http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2017/FY17_Green_Book.pdf.

3 Shaun K. McGee, Stanley A. Horowitz, and John J. Kane, "Analysis of Alternative Mixes of Full-Time Support in the Reserve Components," IDA Document D-8575 (Alexandria, VA: Institute for Defense Analyses, August 2017).

4 John P. Roth, Memorandum to Assistant Secretaries of the Services (Financial Management and Comptroller), "FY 2017 Department of Defense (DoD) Military Personnel Composite Standard Pay and Reimbursement Rates," March 9, 2016.

5 "Full Cost of Manpower," CAPE, https://fcom.cape.osd.mil/.

6 DoD, "Final Report: DoD Force Health Protection and Readiness—A Summary of the Medical Readiness Review, 2004–2007," June 2008.

7 McGee, Horowitz, and Kane, "Analysis of Alternative Mixes of Full-Time Support."

Table B-1. Components of Personnel Cost Estimates

Cost Element	AC Source	RC Source
Cash Flow Costs to DoD		
Basic pay	Composite rate	Defense Finance & Accounting Service (DFAS)
Allowances	Composite rate	DFAS; component budget execution rates
Social Security	Composite rate	Social Security Administration
Medicare	Composite rate	Office of the Under Secretary of Defense (Comptroller) (OUSD(C))
Travel	Composite rate	Component budget justification rates
Health Benefits	Composite rate; OUSD(C)	TRICARE Reserve Select premiums, beneficiary cost shares, and take rates
Retirement	Composite rate	DoD Actuary; USD(P&R)
Incentive and special pays	Service data	Component budget execution rates
Recruitment and advertising	Christensen, et al.[a]	Future Years Defense Program (FYDP)
Training	Christensen, et al.	FYDP
Long Run Costs to DoD		
Child development	Full Cost of Manpower tool (FCoM)	FYDP
Family support services	FCoM	FYDP
Discount groceries	FCoM	FYDP
Separation pay	Medical Readiness Review (MRR)	Service budget justification rates
Unemployment benefits	MRR	FYDP
Death gratuities	MRR	FYDP
Survivor benefits	MRR	FYDP
Costs to Other Departments		
Tax shortfall payment	MRR	Department of the Treasury
Concurrent receipt	DoD Actuary	Department of the Treasury
Child education	FCoM	N/A
VA benefits	Congressional Budget Office (CBO) Report 2002/ Budget Report 2000	CBO estimates adjusted proportionally to component-specific average OIF/OEF disability payment
Employment training	MRR	N/A

[a] Eric W. Christensen et al., "Life-Cycle Costs of Selected Uniformed Health Professions," CRM D0006686.A3 (Alexandria, VA: CNA, April 2003).

Activated RC personnel are paid identically to AC personnel, plus DoD incurs the costs of additional pre-mobilization training and post-mobilization services such as the

Yellow Ribbon Reintegration Program. Using FY 2017 budget justification estimates for overseas contingency operations funding, we derive pre- and post-mobilization costs of $4,633, $4,468, and $5,966 per deployment for the Army, Navy, and Air Force, respectively.

Appendix C. Optimization Method

In this appendix, we specify the linear program used to optimize force mix. In our analysis, all values are defined at the Service-occupation level.

Let:

z_i be the end strength for personnel type i,

c_i^w be the dwell cost for personnel type i,

c_i^d be the marginal deployment cost per period for personnel type i,

M_i be the maximum number of non-deployed personnel for personnel type i,

$x_{i,t}$ be the number of personnel for personnel type i that deploy in period t,

T be the total number of periods,

d_i, l_i, and w_i be the deployment duration, lead time, and dwell duration for personnel type i,

R_t be the rotational deployment demand in period t,

$S_{k,t}$ be the deployment demand for event k in period t,

K be the total number of events, and

τ_k be the first period of event k, such that $\tau_k \leq \tau_{k+1}\ \forall k$ (i.e., the events are ordered by beginning period from earliest to latest).[1]

The optimization program is defined as follows:

Choose the end strengths z_i and deployments $x_{i,t}$ to minimize total cost:

$$\min_{z_i, x_{i,t} > 0\ \forall t, \forall i} \sum_i \boldsymbol{c_i^w z_i} + \sum_i \sum_t \boldsymbol{c_i^d x_{i,t}}$$

such that, in each period:

1. Total deployment demands are met:

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[1] The first period of an event is the earliest period that *may* have a positive demand. That is, we must have $S_{k,t} = 0$ for $t < \tau_k$, but we may have $S_{k,t} = 0$ for some $t \geq \tau_k$.

$$\sum_{i}\sum_{j=0}^{d_i} x_{i,(t-l_i-j)(mod\,T)} \geq R_t + \sum_{k} S_k \;\; \forall t$$

2. Each event's demands may only be met by personnel deploying to that event:

$$\sum_{i}\sum_{j=0}^{\min(d_i, t-\tau_K-l_i)} x_{i,(t-l_i-j)(mod\,T)} \geq \sum_{k=n}^{K} S_{k,t} \;\; \forall t, \forall n \in \{1,2,\ldots,K\}$$

3. The total number of personnel of each type that deploy over the minimum duration of a deployment and dwell cycle does not exceed that type's end strength:

$$\sum_{j=0}^{d_i+w_i} x_{i,(t-j)(mod\,T)} \leq z_i \;\forall t, \forall i$$

4. The number of non-deployed personnel of each type does not exceed the maximum number of that type:

$$z_i - \sum_{j=0}^{d_i} x_{i,(t-j)(mod\,T)} \leq M_i \;\forall t, \forall i$$

The program is linear, non-negative, and solvable by the simplex method.

Appendix D.
Implementation Challenges Request to Services

TFM&RS submitted the following request to the Services for information as part of this study. Detailed responses were received from the Army and Air Force.

Medical Total Force Management: Assessing Readiness and Cost

IDA is conducting a study on including readiness considerations in force mix analysis for the Office of Total Force Management and Resources in OUSD(P&R). IDA has met with each Service medical department (extensively with some Services) and we very much appreciate that support. IDA has one final set of formal questions to ask for the study. We would appreciate responses by August 31, 2017. Please feel free to contact John Whitley, jwhitley@ida.org, with any clarifying questions.

Question 1: What are current challenges to effectively using RC personnel to support operational medical needs and what legal, policy, and programmatic changes can be made to mitigate challenges?

- Please consider both programming (e.g., where to program requirements across AC and RC) and execution (e.g., where to source immediate operational needs).
- Please list any specific changes to law, policy, and/or programs that would allow your Service to more effectively use RC medical personnel.
- If your Service has conducted any specific studies on the challenges and/or changes required to address challenges, please provide references and/or copies if they are releasable to IDA.
- Examples that have arisen in IDA's meetings with DoD include:
    - DHP alignment of manpower authorizations can limit flexibility for total force management, re-aligning manpower authorizations to Services could improve Service incentives and flexibility for efficient total force management.
    - RC recruitment and retention can be underfunded relative to the AC, greater use of RC personnel would require increased investment in RC force management.
- Please provide as much specificity on challenges and legal (e.g., section of code), policy (e.g., policy title), and/or programmatic changes as possible.

Question 2: The IDA study is considering alternative RC options. Please identify any legal, policy, and programmatic changes that your Service would require to effectively use these options.

- The two primary options are:
  - A higher tether reserve contract. This might entail a regular expectation of deployment (according to existing rotation policies) and more stringent readiness requirements, in exchange for higher pay or more generous accession benefits.
  - A lower tether reserve contract. This might entail a strategic reserve that does not drill regularly and is only activated in circumstances of major war. Analogies could include the WWII medical mobilization or Civil Reserve Air Fleet (CRAF).
- Examples that have arisen in IDA's meetings with DoD include:
  - High tether: Higher skill (i.e., providers) personnel have trouble deploying for extended periods of time (e.g., running their practice), greater use would require redesigning deployment length and rotation policies.
  - Low tether: RC can be less reliable and this option could exacerbate this risk, this option would require a dedicated program of audits and testing to ensure availability.
- Please provide any specific changes to law, policy, and/or programs that would be required to allow your Service to effectively use these options.

If desired, please provide views on how the options might be useful to your Service and/or what their limitations would be.

Illustrations

Figures

Tables

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Abbreviations

AC	Active Component
ACS	American College of Surgeons
ADN	Associate’s Degree in Nursing
AFSC	Air Force Specialty Code
APRN	Advanced Practice Registered Nurse
ASD(HA)	Assistant Secretary of Defense for Health Affairs
ASD(M&RA)	Assistant Secretary of Defense for Manpower and Reserve Affairs
ASD(R)	Assistant Secretary of Defense for Readiness
BOLC	Basic Officer Leaders Course
BSN	Bachelor of Science in Nursing
CAPE	Cost Assessment and Program Evaluation
CBO	Congressional Budget Office
CCC	Combat Casualty Care
CCS	Clinical Classification Software
CNA	Certified Nursing Assistant
CNE	Chief Nurse Executive
CNM	Certified Nurse Midwife
CNO	Chief Nursing Officer
CNS	Clinical Nurse Specialist
CNTP	Clinical Nurse Transition Program
CONUS	Contiguous United States
CRAF	Civil Reserve Air Fleet
CRNA	Certified Registered Nurse Anesthetist
CSH	Combat Support Hospital
CTS	Contingency Tracking System
DASD(RI)	Deputy Assistant Secretary of Defense for Reserve Integration
DFAS	Defense Finance and Accounting Service
DHP	Defense Health Program
DMDC	Defense Manpower Data Center
DNP	Doctor of Nursing Practice
DoD	Department of Defense

DOPMA	Defense Officer Personnel Management Act
DRRS	Defense Readiness Reporting System
EMC	Essential Medical Capability
EMT	Emergency Medical Technician
FCoM	Full Cost of Manpower
FST	Forward Surgical Team
FTE	Full-Time Equivalent
FY	Fiscal Year
FYDP	Future Years Defense Program
GAO	General Accounting Office
HHS	Department of Health and Human Services
IDA	Institute for Defense Analyses
IOM	Institute of Medicine
JTTS	Joint Theater Trauma System
LPN	Licensed Practical Nurse
LSMTF	Limited Scope Military Treatment Facility
MARAD	Maritime Administration
MCRMC	Military Compensation and Retirement Modernization Commission
MEPRS	Medical Expense and Performance Reporting System
MET	Mission Essential Task
MGMA	Medical Group Management Association
MHS	Military Health System
MOA	Memorandum of Agreement
MOS	Military Occupational Specialty
MRDSS	(Air Force) Medical Readiness Decision Support System
MRR	Military Readiness Review
MS	Master’s Degree in Science
MSN	Master’s Degree in Nursing
MTF	Military Treatment Facility
NDAA	National Defense Authorization Act
NDMS	National Disaster Medical System
NEC	Navy Enlisted Classification
NGB	National Guard Bureau
NP	Nurse Practitioner
NTR	Nurse Transition and Residency
OCONUS	Outside Continental United States

OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OUSD(C)	Office of the Under Secretary of Defense (Comptroller)
OUSD(P&R)	Office of the Under Secretary of Defense for Personnel and Readiness
PhD	Doctor of Philosophy
RC	Reserve Component
RN	Registered Nurse
ROTC	Reserve Officer Training Corps
RVU	Relative Value Unit
SAMMC	San Antonio Military Medical Center
SME	Subject Matter Expert
TFM&RS	Total Force Manpower and Resources
U.S.C.	United States Code
US	United States
USD(P&R)	Under Secretary of Defense for Personnel and Readiness
USERRA	Uniformed Services Employment and Reemployment Rights Act of 1994

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14. ABSTRACT

The military medical force is an important warfighting resource, but it is also large and expensive. This paper extends past medical force mix analyses to include assessment of clinical readiness and the trade-off between Active and Reserve forces. Limited volume of readiness-related workload at military hospitals hinders clinical readiness of Active forces, requiring reconsideration of alternative force mix options. Four alternatives are studied: Active Duty providers stationed in military hospitals that have been expanded to become trauma centers, Active Duty providers stationed in civilian facilities, Reserve forces working in civilian employment that maintains clinical currency, and strategic Reserve forces maintained by civilian trauma centers. This paper finds that a more effectively managed mix of these alternatives can attain a higher level of readiness at lower cost and that military-to-civilian conversion opportunities are more numerous than previous research has found.

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Medical force; readiness; total force mix; Reserve forces

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