

# Assessment of Medical Readiness Contributions of U.S. Army Hospitals and Clinics: A Composite Index

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### Background and purpose

The mission of the U.S. Army Medical Department is to provide sustained health services and research to enable readiness and conserve the fighting strength— while caring for its Soldiers for Life and Families. Army Medicine “develops Personnel & Capabilities that provide premier expeditionary health services that support **no-notice rapid** deployments with **Mission Ready Personnel** able to transition from garrison to Operational Units.”

Medical Readiness, from an Army perspective can be broken down into two components:

- **“Medically Ready Force”**: Promoting a healthy and fit fighting force that is medically prepared to provide the Army with the maximum ability to accomplish their deployment missions throughout the spectrum of military operations
- **“Ready Medical Force”**: Ensuring Army Medicine (AMEDD) personnel are fully trained, experienced, clinically current, and prepared to deploy in their war-time mission and meet the demands of expeditionary medicine.

MEDCOM PAE was asked to construct a composite index to assign readiness scores to each MTF, assessing the “Relative Medical Power” of Army MTFs. This is analogous to determining “Relative Combat Power” used by military planners to assess a unit’s ability to generate overwhelming combat power.

The *Composite Readiness Talley (CRT)* measures the “Relative Medical Readiness Power” of the 32 Army MTFs, using current performance and capability measures posted on DHA/Army Medicine dashboards or centralized data repositories.

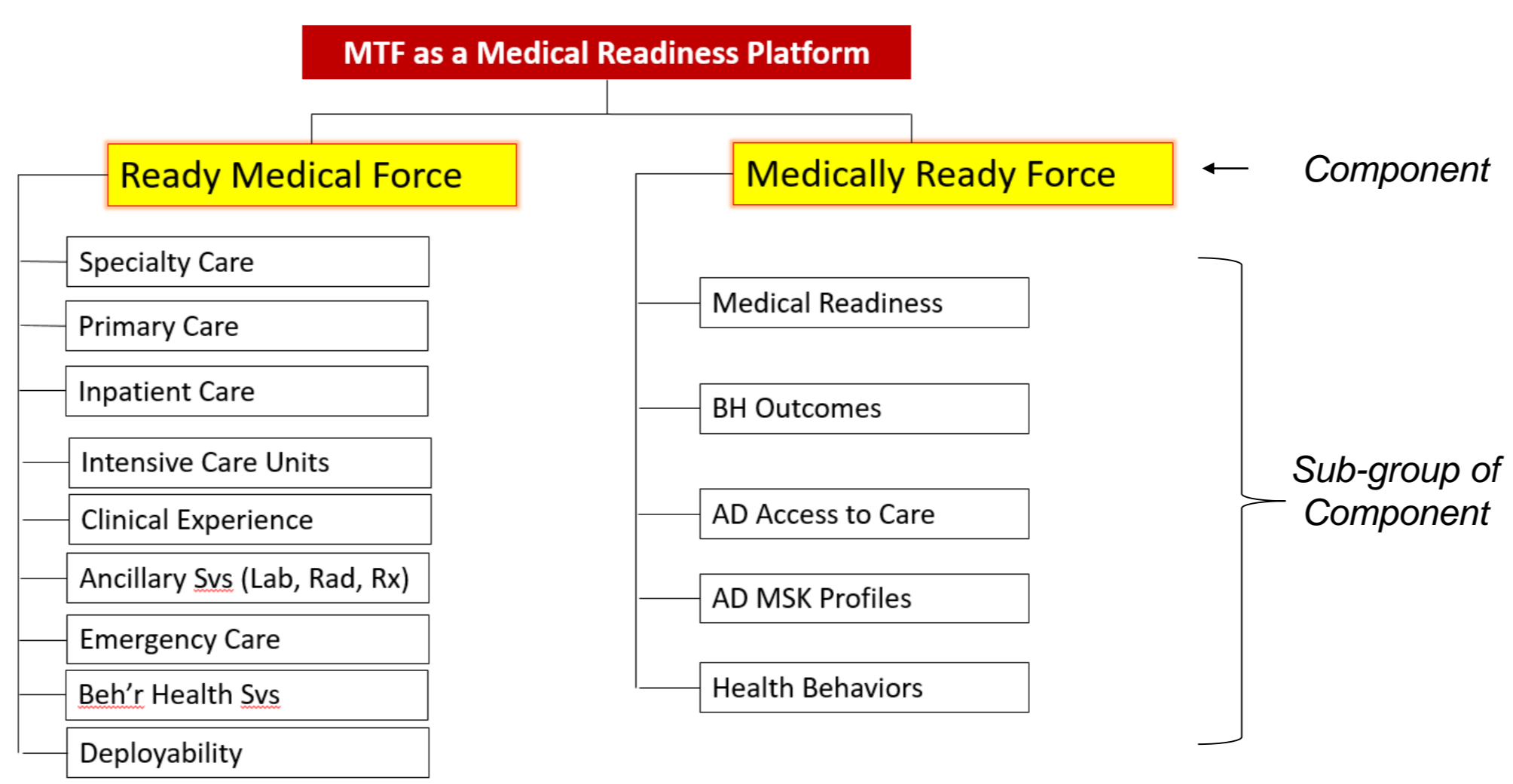


Fig 1: Components and sub-groups of the Composite Readiness Talley index

### Description of the index

The CRT is divided into 2 components: The “Ready Medical Force” section, assessing the MTFs capabilities and performance in ensuring optimal clinical experiences for military medical officers and enlisted personnel, as well as a “Medically Ready Force” section, assessing wellness and readiness outcome measures for the Active Duty populations they serve.

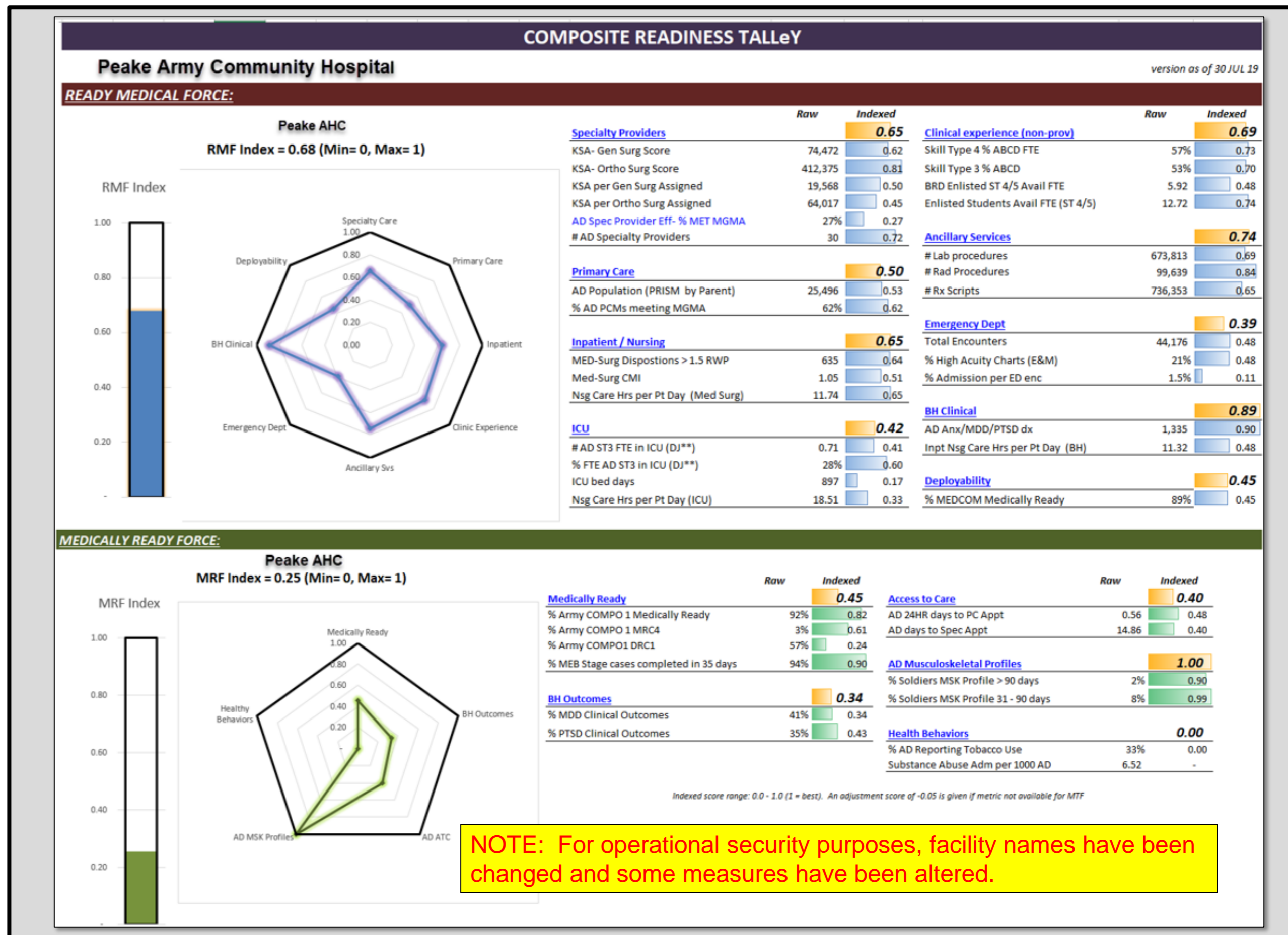
Each component was broken down into various sub-groups which are part of the overall readiness component (see Fig 1). Performance measures, from central military health data systems were identified for each sub-group for each of the Army’s 32 major clinics, hospitals, and medical centers. Reference time frame was period ending March 2019.

Using various platforms in JMP to normalize and standardize each measure, a composite score and index was calculated using principal components for each of the 9 Ready Medical Force sub-group and 5 Medically Ready Force sub-groups. A final composite index was then calculated for both of the 2 main components.

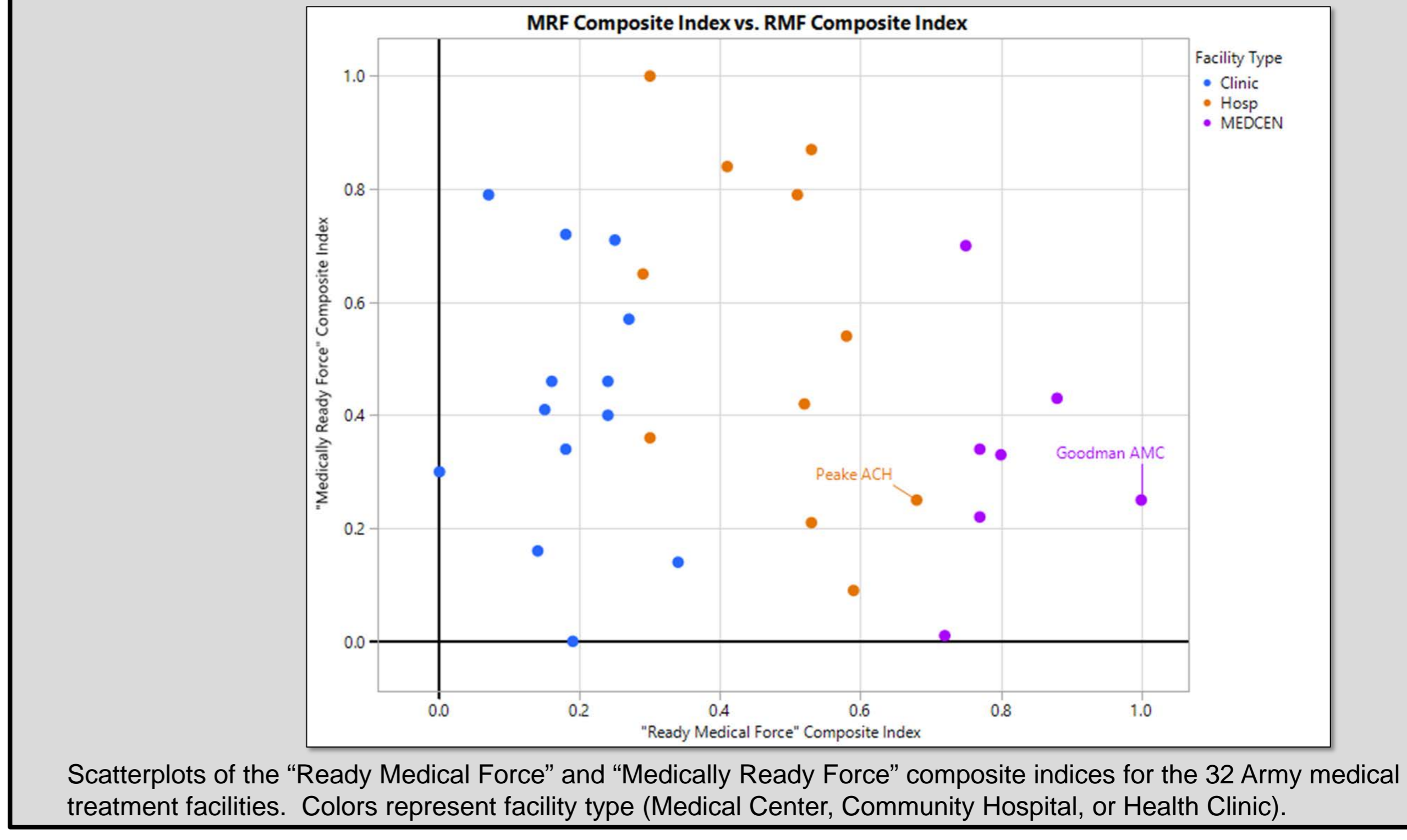
### Uses of the Composite Readiness Talley Index and Way-ahead

The index can be used to summarize a single medical facilities capabilities, identify centers of “medical readiness” to station Army Medicine personnel for clinical opportunities, and help identify where to expand or contract capabilities.

As additional metrics and measures to measure medical readiness become available, they can be added to the CRT in future updates.



ABOVE: Dashboard display of the Inpatient Readiness Talley for an Army Community Hospital



Scatterplots of the “Ready Medical Force” and “Medically Ready Force” composite indices for the 32 Army medical treatment facilities. Colors represent facility type (Medical Center, Community Hospital, or Health Clinic).



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## Measure Selection

For the “Ready Medical Force” component, 27 performance and capability measures were identified and assigned to one of the 9 sub-groups (see Table 1). 12 performance and outcome measures selected across the 5 sub-groups for the “Medically Ready Force” component (see Table 2).

## Assess for Normalization / Transformation

For each measure, the histograms were assessed using the JMP distribution platform, and a ‘goodness-of-fit’ test for normality was applied. If the Shapiro-Wilks W test was significant, the data were transformed to achieve a normal distribution. This prevents the impact of outliers or extreme values from significantly influencing benchmarks, while respecting the theoretical framework and the data properties.

For those measures with reverse scoring (i.e., a lower score was “better”), the measures were multiplied by “-1” to ensure that higher scores were indicative of better performance (Fig. 2).

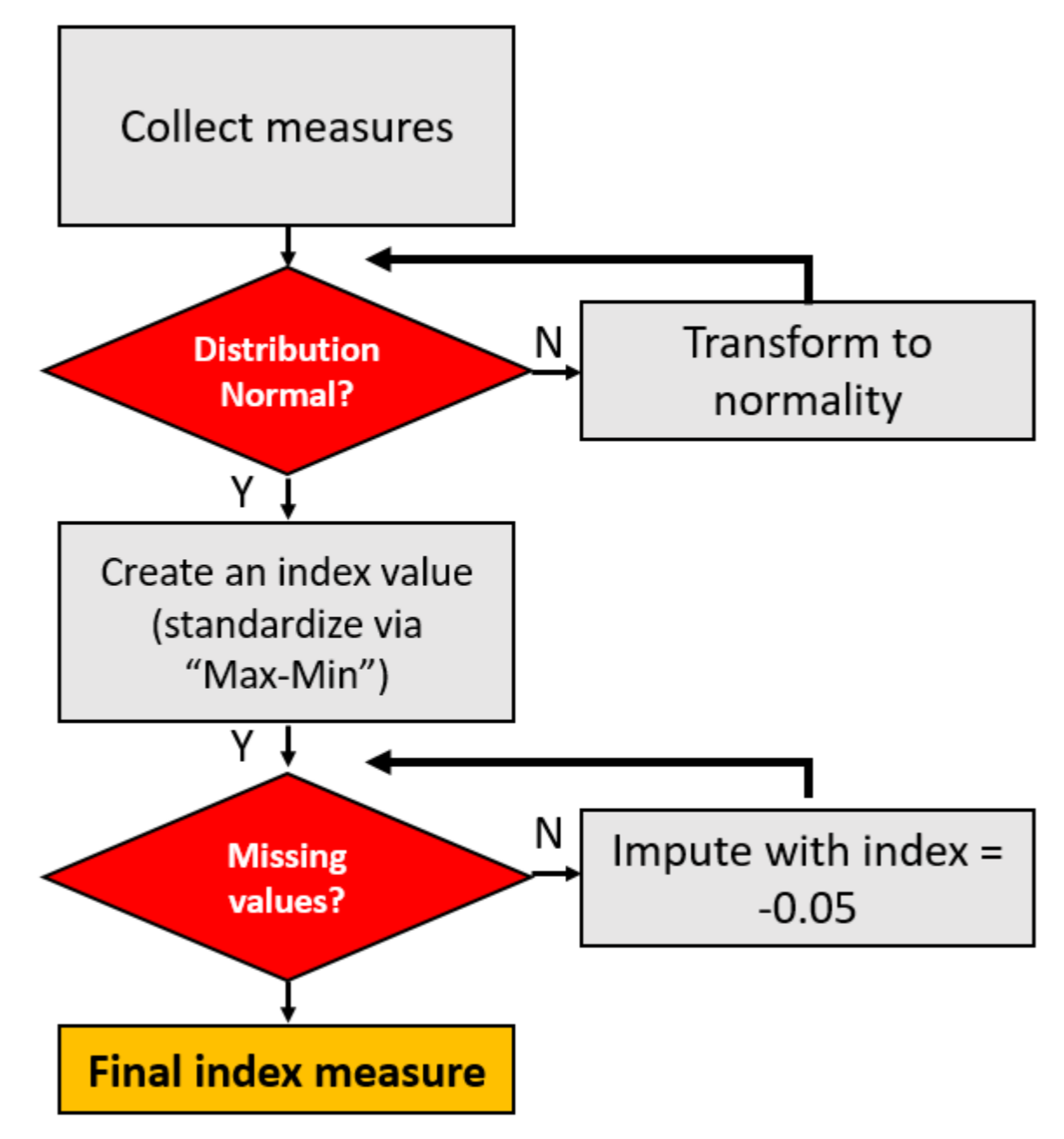
## Standardization and Indexing

For each measure (transformed or non-transformed), summary statistics were calculated (see Tables 1 and 2). Each measure’s values were then standardized into an indexed score, using a Max-Min methodology, to ensure each indexed measure had an identical range of 0 to 1.

$$T(x_i) = \frac{x_i - \min(x_1, x_2, \dots, x_n)}{\max(x_1, x_2, \dots, x_n) - \min(x_1, x_2, \dots, x_n)}$$

For MTFs with missing values (likely due to not have a specific capability, such no inpatient services or no specialty providers), an adjusted index value of -0.05 is imputed, to prevent equal scoring with the lowest ranking facility that has data (Fig.3).

## Process of normalizing and indexing measures in the CRT



## Transformation to normality

- Assess each variable set comparing to normal distribution.
- If skewed, or extreme outlier, transform values to better fit normal distribution (log<sub>e</sub> or exponential).
- In the case of “Lower is better”, multiply values by -1.00, prior to obtaining summary statistics.

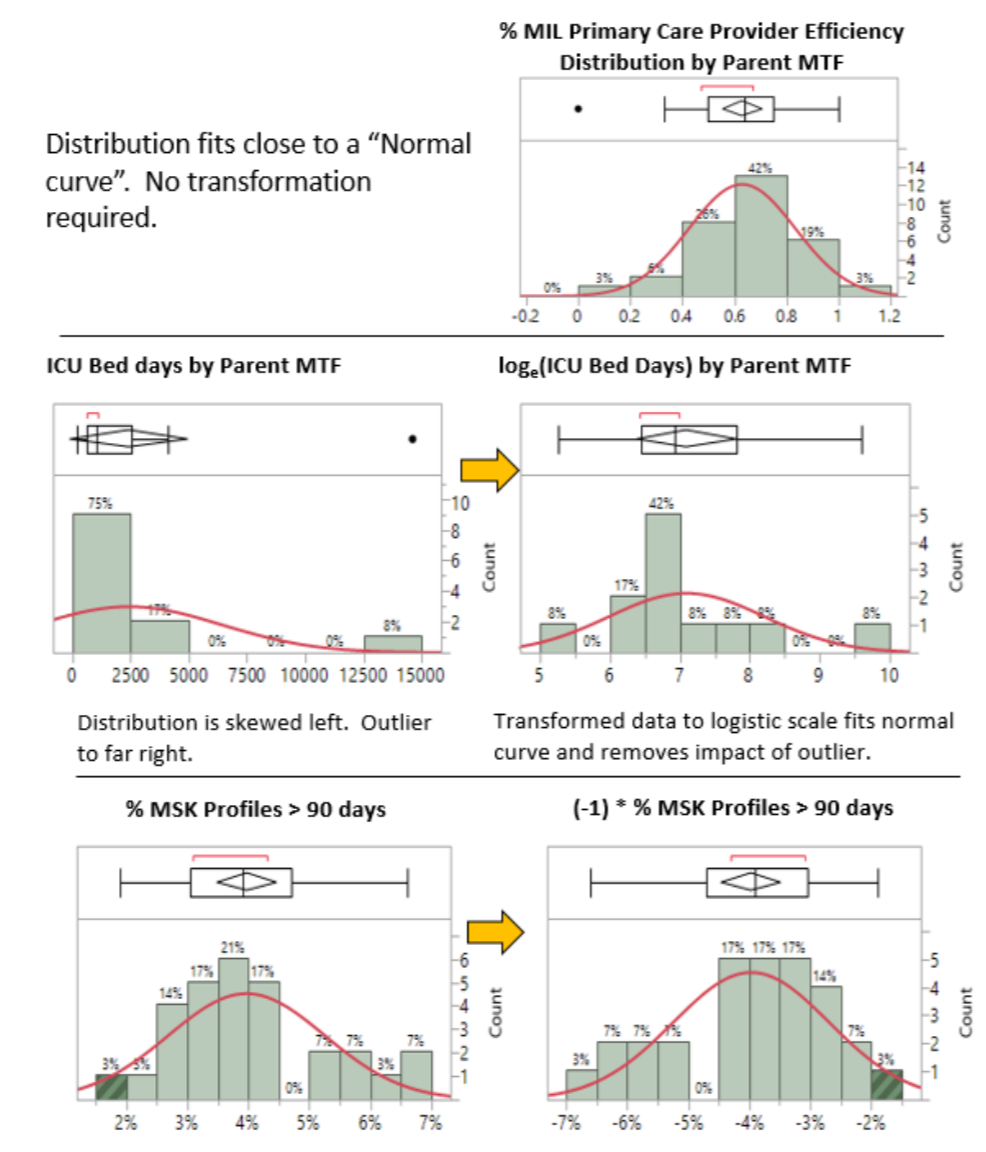


Fig 2: Normalization and transformation techniques

## “Ready Medical Force” Measures by Sub-group

			Mean	Min	Max	Transformation (if needed)
Specialty Care	KSA-General Surgeon score	Reflection of a General Surgeon’s current MTF workload as it relates to downrange workload. (KSA: Knowledge, Skills, and Abilities)	101,430	3,533	486,039	Natural logarithmic
	KSA-Orthopedic Surgeon score	Reflection of an Orthopedic Surgeon’s current MTF workload as it relates to downrange workload.	358,447	1,868	1,459,997	Natural logarithmic
	KSAs per General Surgeon Assigned	General Surgery KSA score divided by # of assigned general surgeons	15,685	5,491	33,417	
	KSAs per Orthopedic Surgeon Assigned	Orthopedic Surgery KSA score divided by # of assigned ortho surgeons	68,376	1,292	140,440	
	Military Specialty Provider Efficiency	Proportion of Military Specialty Physicians meeting expected workload targets	43.59%	0%	100%	
	# of Military Specialty Providers	Count of assigned Military Specialty Physicians assigned to the MTF	26	1	109	Natural logarithmic
Primary Care	% Military Primary Care provider efficiency	Proportion of Military Primary Care Providers meeting expected workload targets	65.03%	0%	100%	
	Active Duty Military Population	Annualized number of Active Duty military residing within 20 miles of the MTF.	14,964	785	47,203	Square Root
Inpatient Care	High-Acuity Medical-Surgical Admissions	Count of Admission where the Relative Weighted Product >= 1.5 (excludes Maternal-Child and Behavioral Health)	736	13	5,589	Natural logarithmic
	Medical-Surgical Case Mix Index	Measures the relative resource intensity of the MTF’s admissions--average RWP per admission-- proxy for acuity (excludes Maternal-Child and Behavioral Health)	1.09	0.73	1.49	Natural logarithmic
	Nursing Care Hours per Patient day: Med/Surg units	Measures relative Nursing task related workload for inpatient Medical / Surgical units (excludes ICU’s, Maternal-Child and Behavioral Health)	10.33	6.85	14.36	
Intensive Care	Number of Military Nurses FTE in ICU workcenter	Available military RNs engaged in ICU patient care (via reported FTEs)	3.71	0.66	23.8	Natural logarithmic
	% of Military Nurses working in ICU	Sum of Military RN FTEs in ICU/ Sum of All RNs in ICU	21.82%	0.20%	45.00%	
	ICU beds days	Sum of occupied bed days in ICU	3,327	492	46,757	Natural logarithmic
	Nursing Care Hours per Patient day: Intensive Care units	Measures relative Nursing task related workload for Intensive Care Units (excludes Neonatal and Pediatric Units)	20.11	13.15	29.59	
Clinical Experience (Non-providers)	% Military Paraprofessional time in Clinical Workcenters	Available time in Clinic workcenters (wards, units, clinics, OR, ancillaries) divided by Total available time -- Military Paraprofessionals only	56.62%	23.76%	66.98%	Exponential
	% Military RN time in Clinical Workcenters	Available time in Clinic workcenters (wards, units, clinics, OR, ancillaries) divided by Total available time -- Military RNs only	42.15%	0%	69.36%	Exponential
	Number of enlisted students	Count of enlisted students working in MTF (such as Phase II training programs)	20.08	0	196.5	Natural logarithmic
MTF Medically Ready	% MTF Military assigned Medically Ready	Of all Military assigned to MTF, % who are designated Medical Readiness Category = MRC1	89.56%	84.11%	94.72%	
Ancillary Services	Number of Lab Procedures	Sum of service counts from Laboratory workload (Excludes Modifier for professional component)	481,227	23,241	2,989,379	Natural logarithmic
	Number of Radiology Procedures	Sum of service counts from Radiology workload (Excludes Modifier for professional component)	48,591	835	246,096	Natural logarithmic
	Number of Scripts dispensed	Sum of pharmacy workload, number of prescriptions filled (Source System = D, direct care only)	556,229	27,708	154,642	Square Root
Emergency Care	Number of Emergency Department Encounters	Count of encounters reported in Emerg Dept workcenter	33,217	5,508	85,440	
	% High Acuity encounters	Measure of average ER acuity. Using E&M codes 99281 – 99285, the percentage of E&M encounter using 99284 or 99285	19.27%	0.06%	44.51%	
	% Admissions from Emergency Dept	% of ED workcenter encounters where the disposition status of patient was admitted to the MTF. Demonstrates acuity and generation of MTF inpatient workload (and clinical readiness opportunity). Does not include transfers to other facilities.	4.17%	0.02%	13.21%	
Behavioral Health (Clinical)	Nursing Care Hours per Patient day: Behavioral Health units	Measure of average nursing acuity on Behavioral Health inpatient units	11.58	7.5	15.48	
	Anxiety/Major Depressive Disorders/PTSD Dx counts	Volume of AD Service members with at least one diagnosis of Anxiety, MDD, or PTSD in a 12-month period, seen at the MTF.	702	43	1991	Natural logarithmic

Table 1: List of “Ready Medical Force” measures by sub-group, with summary statistics and transformation (if performed)

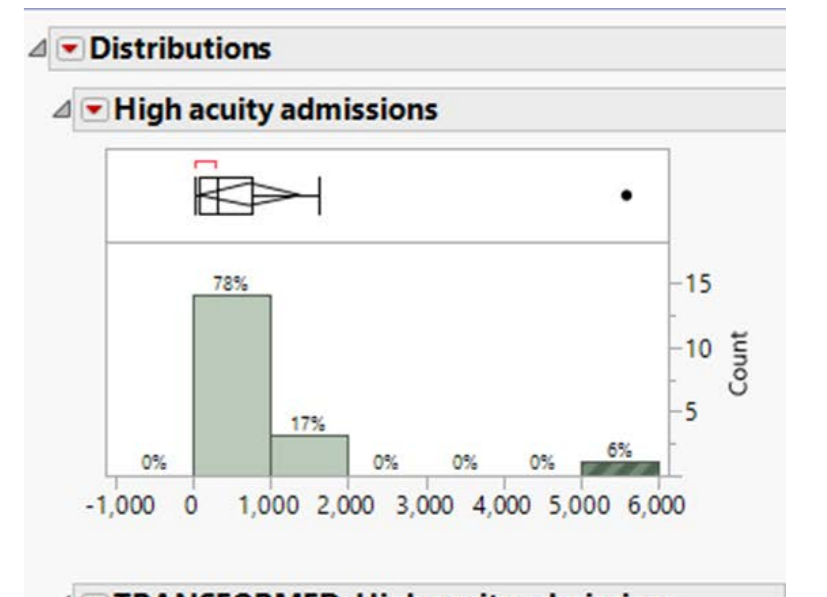
**NOTE: For operational security purposes, facility names have been changed and some measures have been altered.**

## “Medically Ready Force” Measures by Sub-group

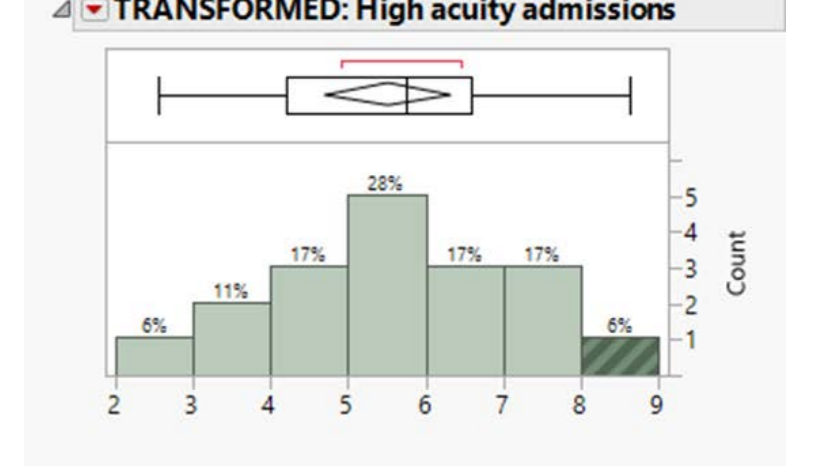
			Mean	Min	Max	Transformation (if needed)
Medical Readiness	% Active Duty Soldiers Medically Ready	Measures the medical deployability of Soldiers served by the installation MTF	89.90%	82.30%	93.70%	
	% Active Duty Soldiers w/Medical Readiness Category = 4	Measures proportion of Soldiers in a deficient readiness status (PHA, DRC4, or other)	3.12%	0.70%	6.87%	Negative (-1)
	% Active Duty Soldiers w/Dental Readiness Category = 1	Measures the dental deployability of Soldiers served by the installation MTF	68.08%	48.60%	84.30%	
	% Medical Evaluation Board (MEB) cases completed within 30 days	Measure compliance with Disability Evaluation System/Medical Evaluation Board timelines	73.15%	38.35%	100%	
Behavioral Health (Outcomes)	Major Depressive Disorder Clinical Outcomes	Measure of effective treatment of MDD, based on patient input. The outcome metrics include patients with 1-6 months of treatment and show the rate of positive outcomes for a rolling six months.	44.04%	31.84%	60.00%	
	PTSD Clinical Outcomes	Measure of effective treatment of PTSD, based on patient input. The outcome metrics include patients with 1-6 months of treatment and show the rate of positive outcomes for a rolling six months.	35.57%	23.81%	48.94%	
Military Access to Care	Military patient Days to Primary Care Appointment (Urgent)	Average time between the request for care to the appointment date/time for Military patient’s seeking an acute Primary Care appointment.	0.57	0.16	1.74	Natural logarithmic & Negative (-1)
	Military patient Days to Specialty Appointment	Average time between the request for care to the appointment date/time for Military patient’s seeking a Specialty appointment.	12.07	6.76	20.3	Negative (-1)
Musculoskeletal Profiles	% Soldiers on Musculoskeletal profile > 90 days	% of Soldiers on a duty-limiting restriction due to musculoskeletal injury or condition, for a period > 90 days	4%	2%	7%	Negative (-1)
	% Soldiers on Musculoskeletal profile 30-90 days	% of Soldiers on a duty-limiting restriction due to musculoskeletal injury or condition, for a period between 30 - 90 days	12%	8%	19%	Negative (-1)
Healthy Behaviors	% Military Reporting Tobacco Use	Measures the number of Soldiers reporting whether they use Smoke, Smokeless or Both over the total number of Soldiers at time of appointment.	22%	7%	33%	Exponential & Negative (-1)
	Substance abuse admissions per 1,000 Military	Number of Active Duty admissions (Direct care and Purchased care) for Substance abuse.	3.43	1.04	6.52	Negative (-1)

Table 2 (Above): List of “Medically Ready Force” measures by sub-group, with summary statistics and transformation (if performed)

a. Distribution of RAW measure values



b. Normalized measures via transformation



c. Indexed values (Range from 0 – 1). Note facilities with no data for measure are adjusted to -0.05

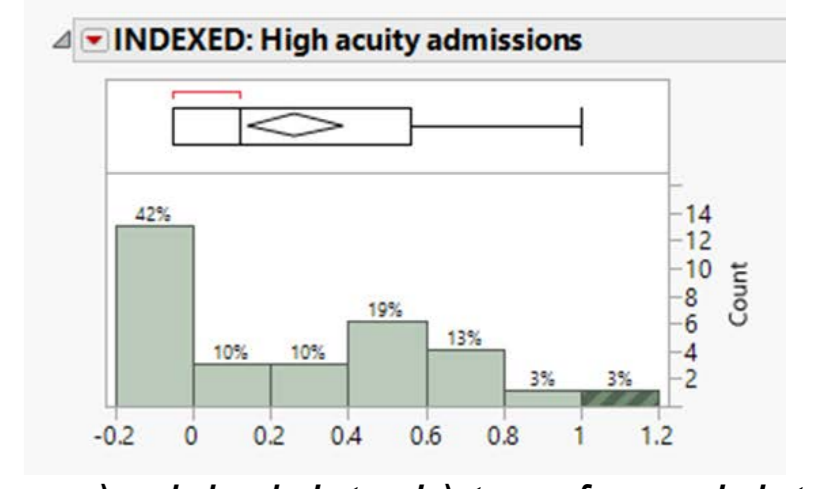


Fig 3: Histogram for “% High acuity admission based on : a) original data, b) transformed data, c) indexed data

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### Creating a Sub-group Composite Score

Once the individual variables have been normalized and standardized to a [0,1] index, a Sub-group index score can be calculated, using the measures identified in each sub-group.

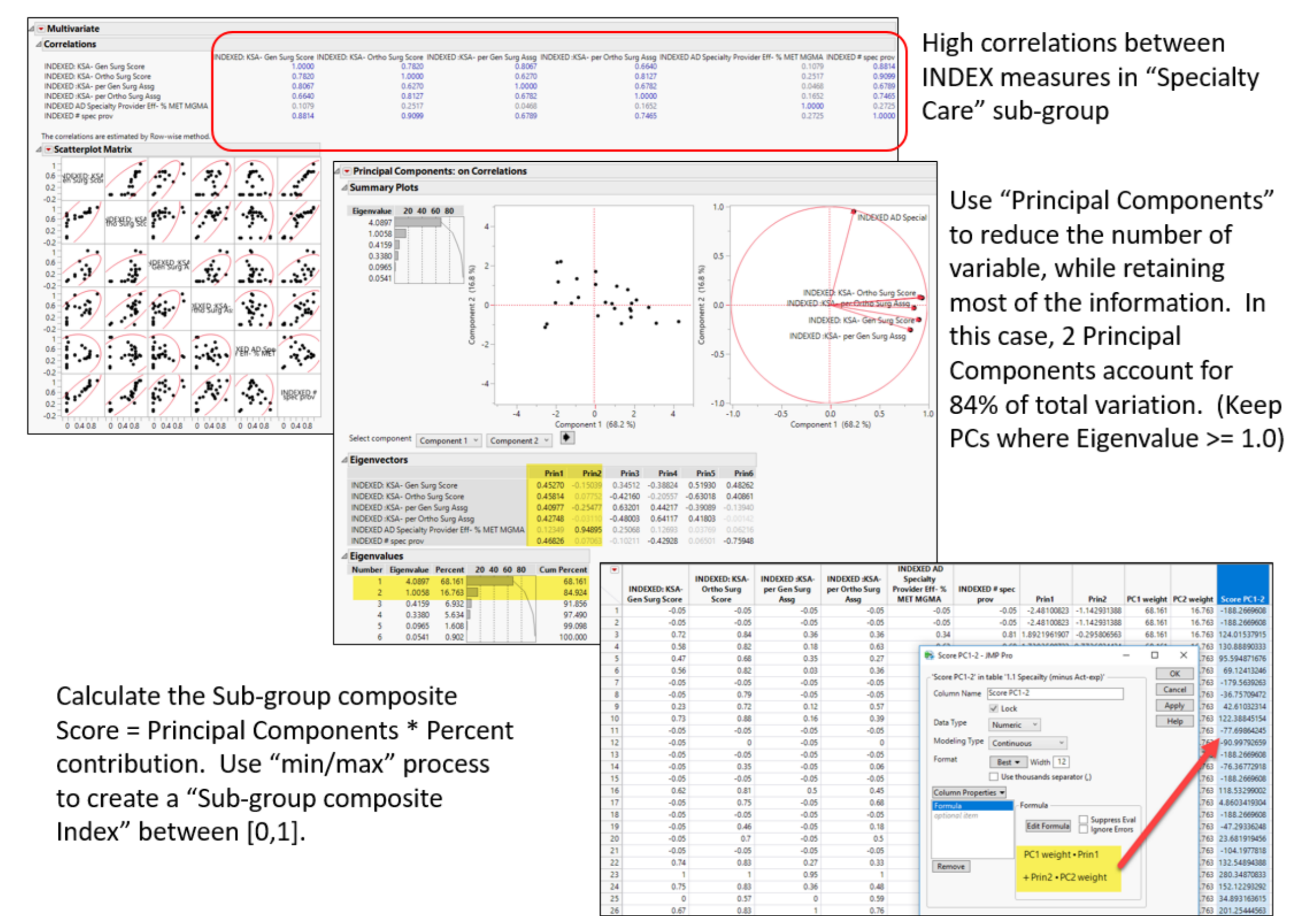
For each sub-group, a Sub-group composite Index was created using “Principal Components” of the indexed measures for each specific sub-group, using the Multivariate Platform in JMP. Principal Component Analysis reduces the number of variables, while eliminating the unnecessary correlations between variables, and retaining the key information.

To calculate the Sub-group composite Index score, we summed those Principal Components where the eigenvalues are greater than or equal to 1, multiplied by their respective percent contribution.

$$\sum_{i=1}^n ([Prin_i] \times [\% contribution_i])$$

...for each eigenvalue  $\geq 1$

An example of calculating the Composite Index for the Specialty Care Sub-group is displayed in Figure 3.



### Creating Composite Scores for Readiness Components

For Both the RMF and MRF components, averages of the Sub-group composite indexes were calculated for each component to determine a Component Composite Average, which was then converted into a Component Composite Index, using the Max-Min process (Fig. 4). A comparison of the distributions of the Ready Medical Force and Medically Ready Force components’ Composite Index distributions for all Army medical facilities is displayed in Fig. 5.

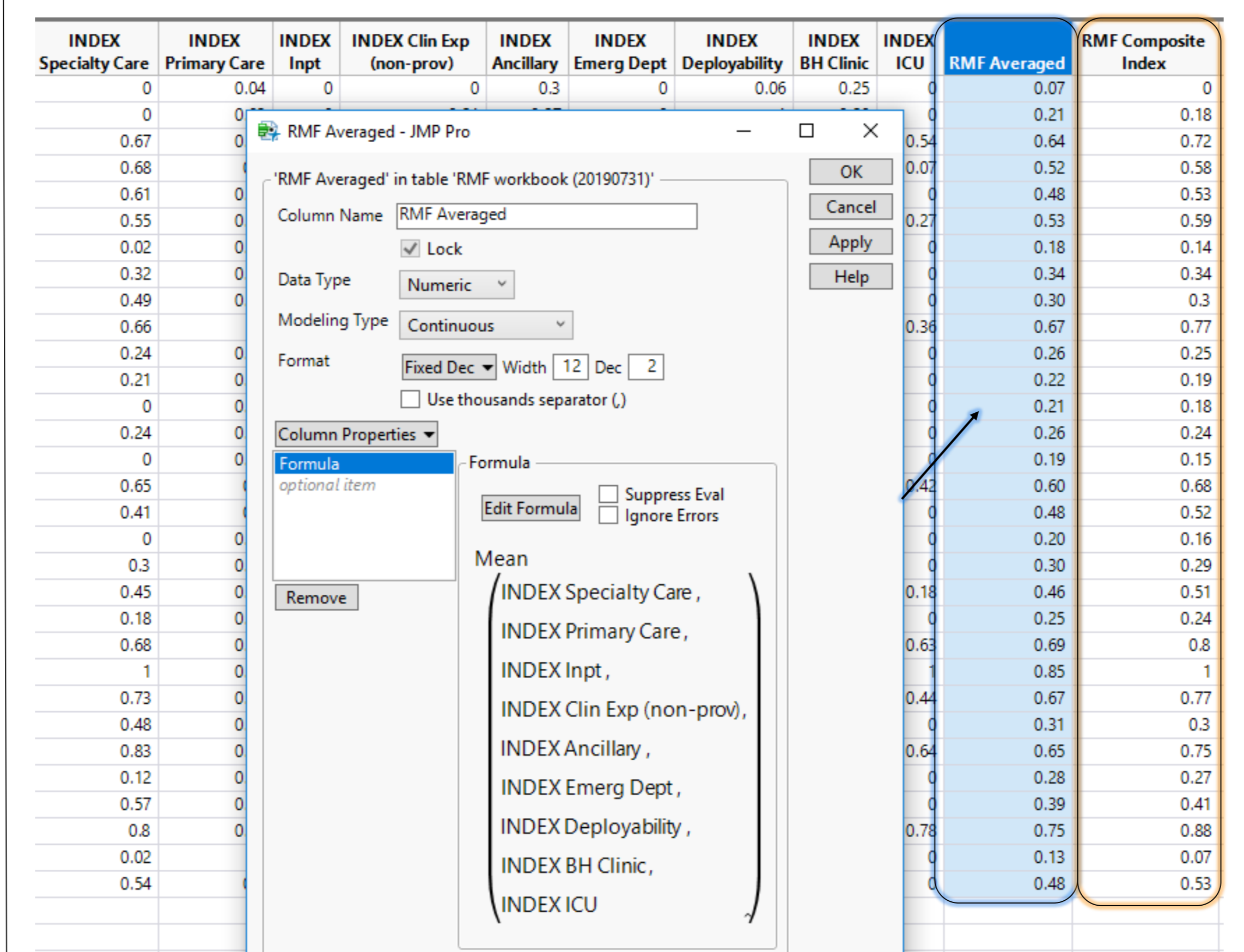
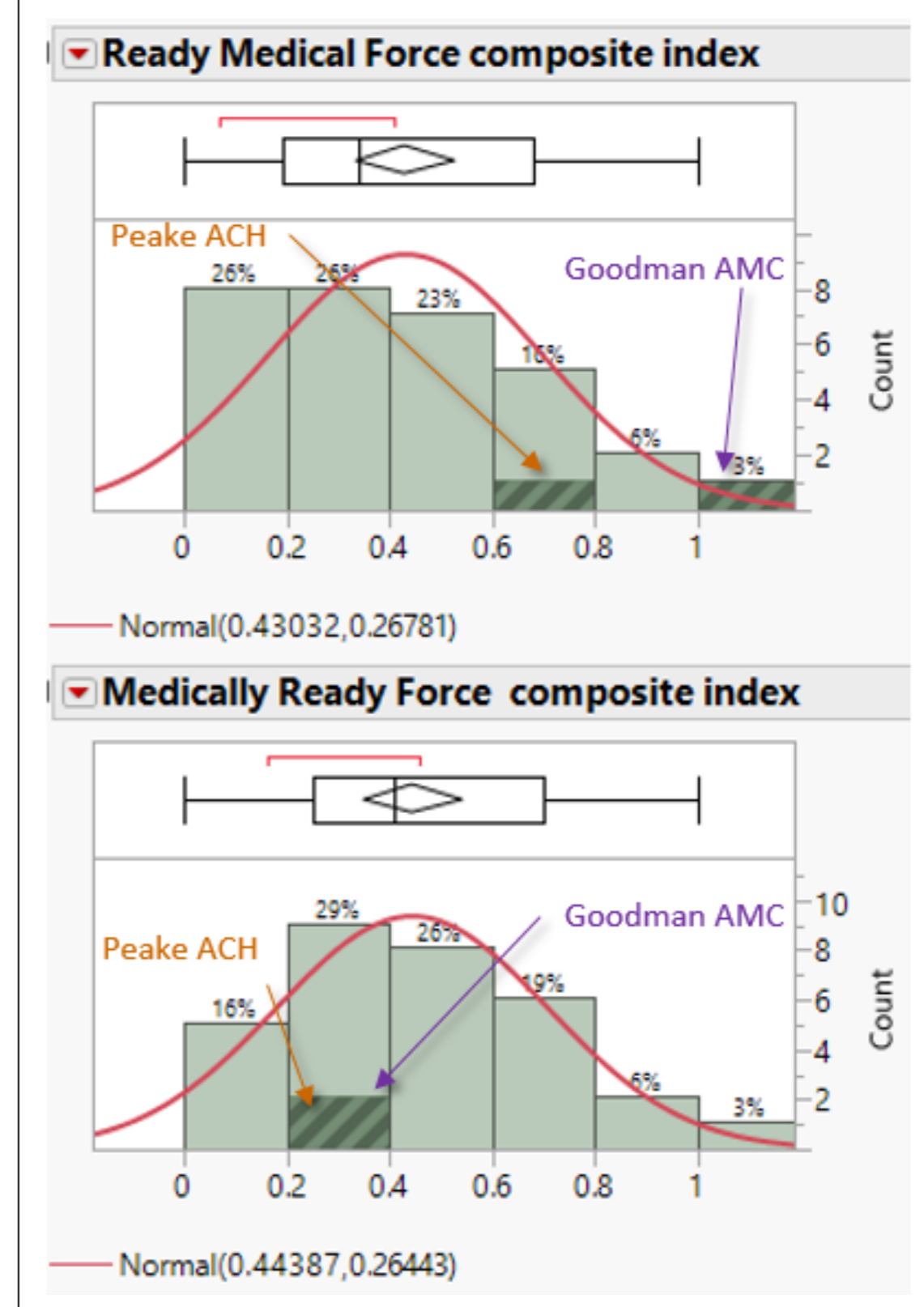


Fig 4: Calculating the Ready Medical Force Component average score, using the Formula editor. From the average score, the RMF Composite Index is calculated using the Max-Min process, providing a range between 0 and 1.



GOODMAN AMC has the largest composite index for Ready Medical Force, which is unsurprising, as it is the Army’s largest tertiary healthcare facility. Peake AHC’s RMF composite index is the highest among all non-MEDCEN Army MTFs.

The Medically Ready Force composite index for both GOODMAN AMC and PEAKE AHC are below the median. There is no correlation between RMF and MRF indices.

Both RMF and MRF Composite indices are normally distributed. (Shapiro-Wilkes W test p-value > 0.5)

Fig 5: Comparing the distributions between the RMF and MRF Composite Indices

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### General observations of Sub-Group Component Indices

There were high correlations ( $r > 0.80$ ) between several pairs of the indices for the Ready Medical Force component sub-groups (Fig. 6). This is not surprising, since medical facilities (such as tertiary medical centers) have higher acuities, volumes, and other specialty services and training programs—making them stronger platforms for clinical experiences that military medical personnel require for clinical skill readiness. Deployability (the individual medical readiness of medical personnel assigned to the facility) was the only sub-group without any strong correlation to any other sub-group ( $r = [-0.30, -0.03]$ ).

There were weak-to-no correlations between the indices for the Medically Ready Force component sub-groups [0.45, -0.32] (Fig.7). This is not surprising due to the many facets of individual medical readiness, which can vary between installations, and type of missions units perform.

### General observations of overall Component Indices

Displaying the Ready Medical Force and Medically Ready Force composite indices for all Army medical facilities on a scatterplot show no correlation (Fig. 8). There were significant differences between the RMF Composite Indices by facility type (Tukey HSD p-value  $< 0.0001$  for all combinations). However, no significant differences in MRF Composite indices by facility type.

### Correlations between RMF Sub-group Composite Indices

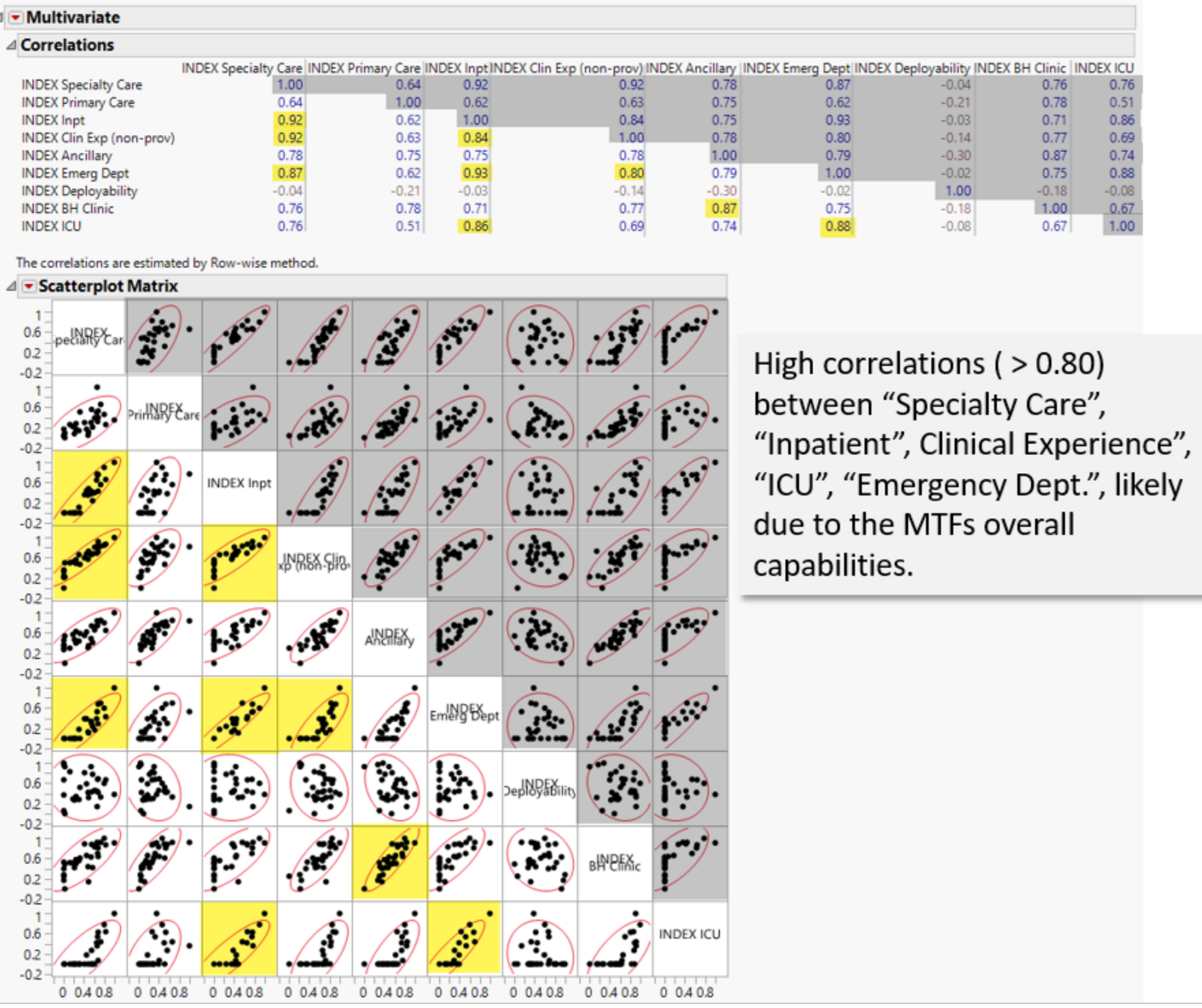


Fig 6: Multivariate display of Ready Medical Force Indices

### Correlations between MRF Sub-group composite Indices

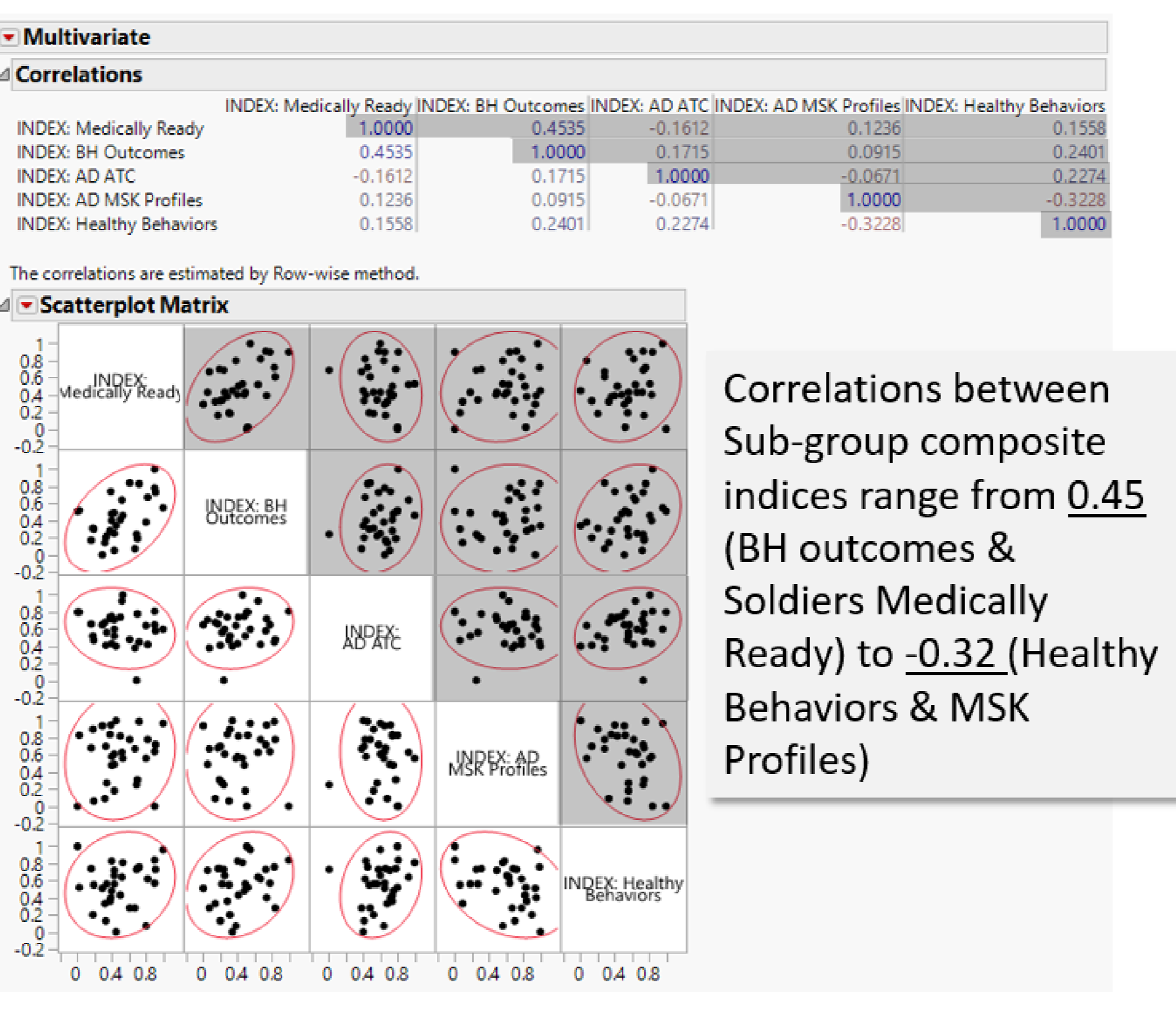


Fig 7: Multivariate display of Medical Ready Force Indices

### MRF Composite Index vs. RMF Composite Index for Army Medical Facilities

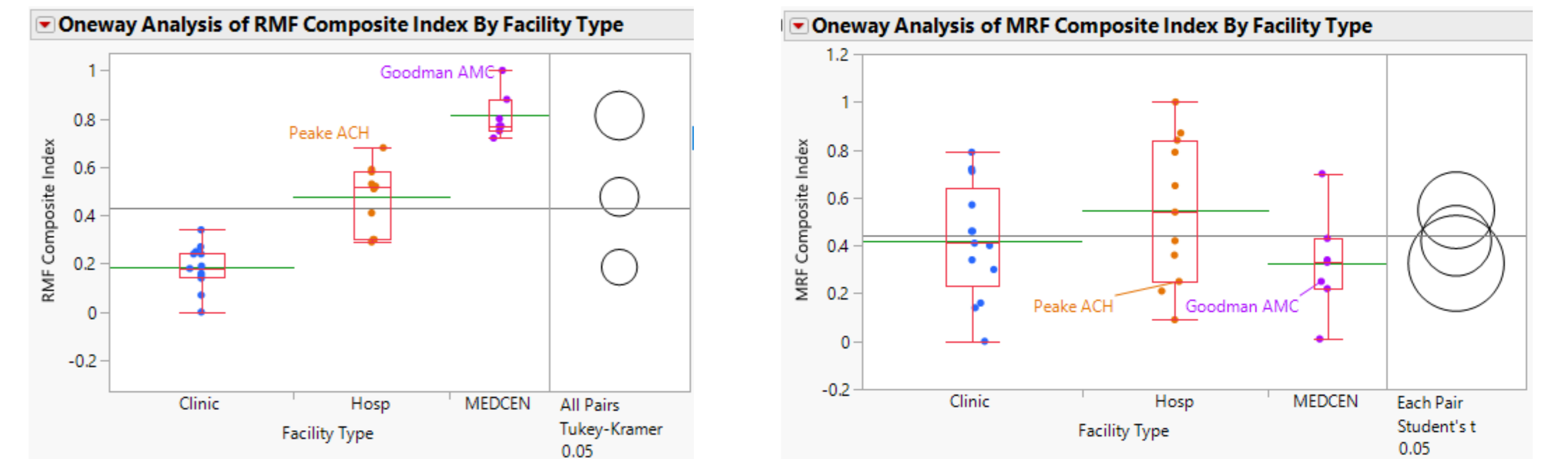
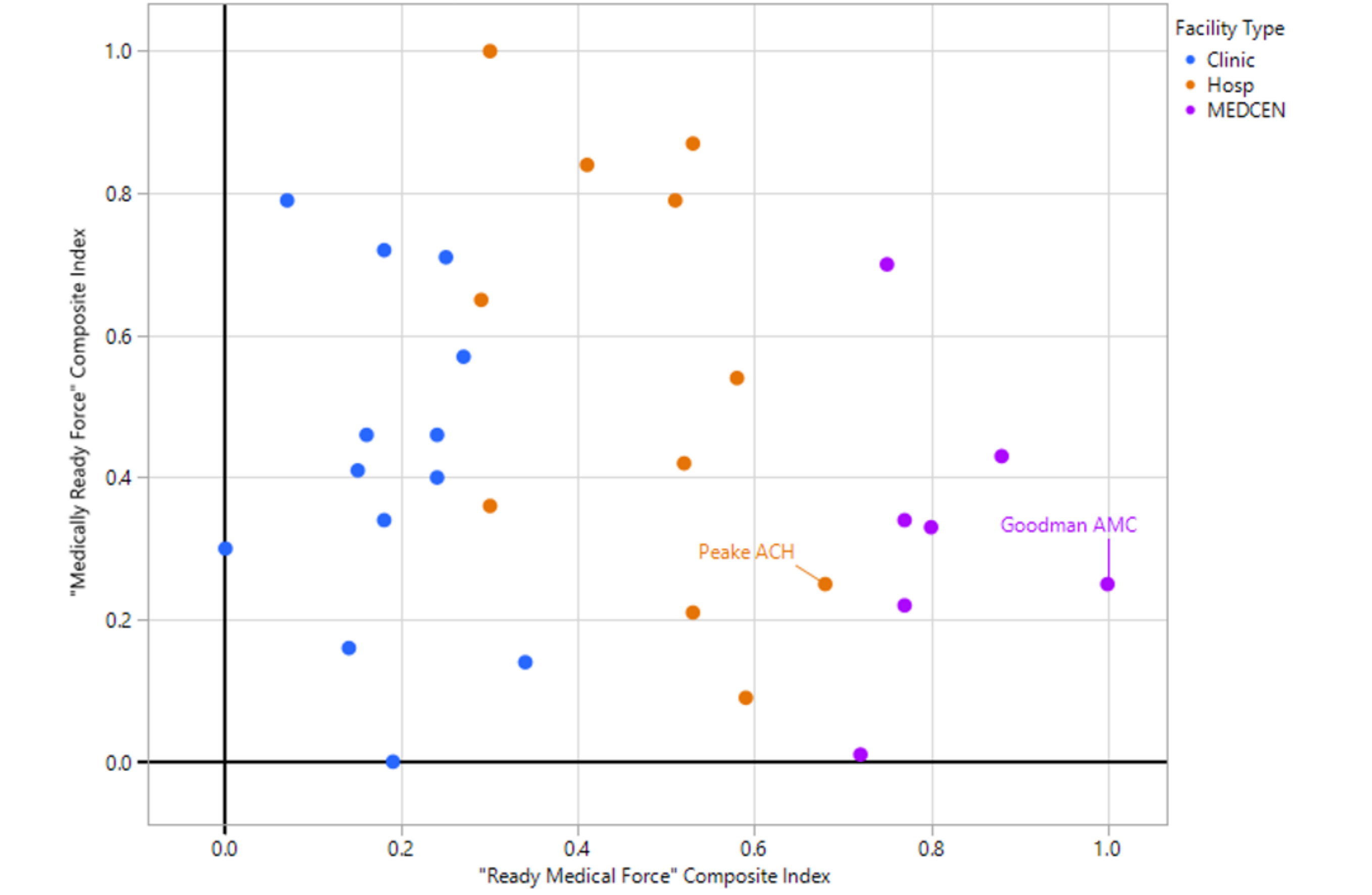


Fig 8: TOP: Scatterplot of "RMF" and "MRF" composite indices. ABOVE: ANOVA box-plots displaying MRF and RMF composite indices by Medical Facility Type

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Dashboards displaying the various measures and indices associated with the Composite Readiness Talley index were developed to allow leaders to quickly view and compare the amount of “relative medical readiness” of Army Medical facilities (Fig. 9).

These displays have been used to assist DoD and Army decision makers in assessing the readiness generated by Army medical facilities, and to ensure proper scoping and staff as the Military Health System is undergoing transformation.

### Summary

Army Medicine’s mission remains unchanged; the way we quantify the readiness value has changed.

As measures of medical readiness continue to be developed-- such as those tracking completion of critical expeditionary clinical tasks – they can be easily integrated into future editions of the CRT.

The CRT index allows Army and Military Health System Leaders to assess the relative amount of medical readiness that a medical facility produces. This information can help Commanders assess the readiness of Soldiers assigned to their installation, the readiness capabilities and outcome measures associated with the medical facility, and the expeditionary clinical experience environment for Army Medicine personnel with duty at the medical facility.

### Composite Readiness Talley Dashboards for 2 Army Medical Facilities\*

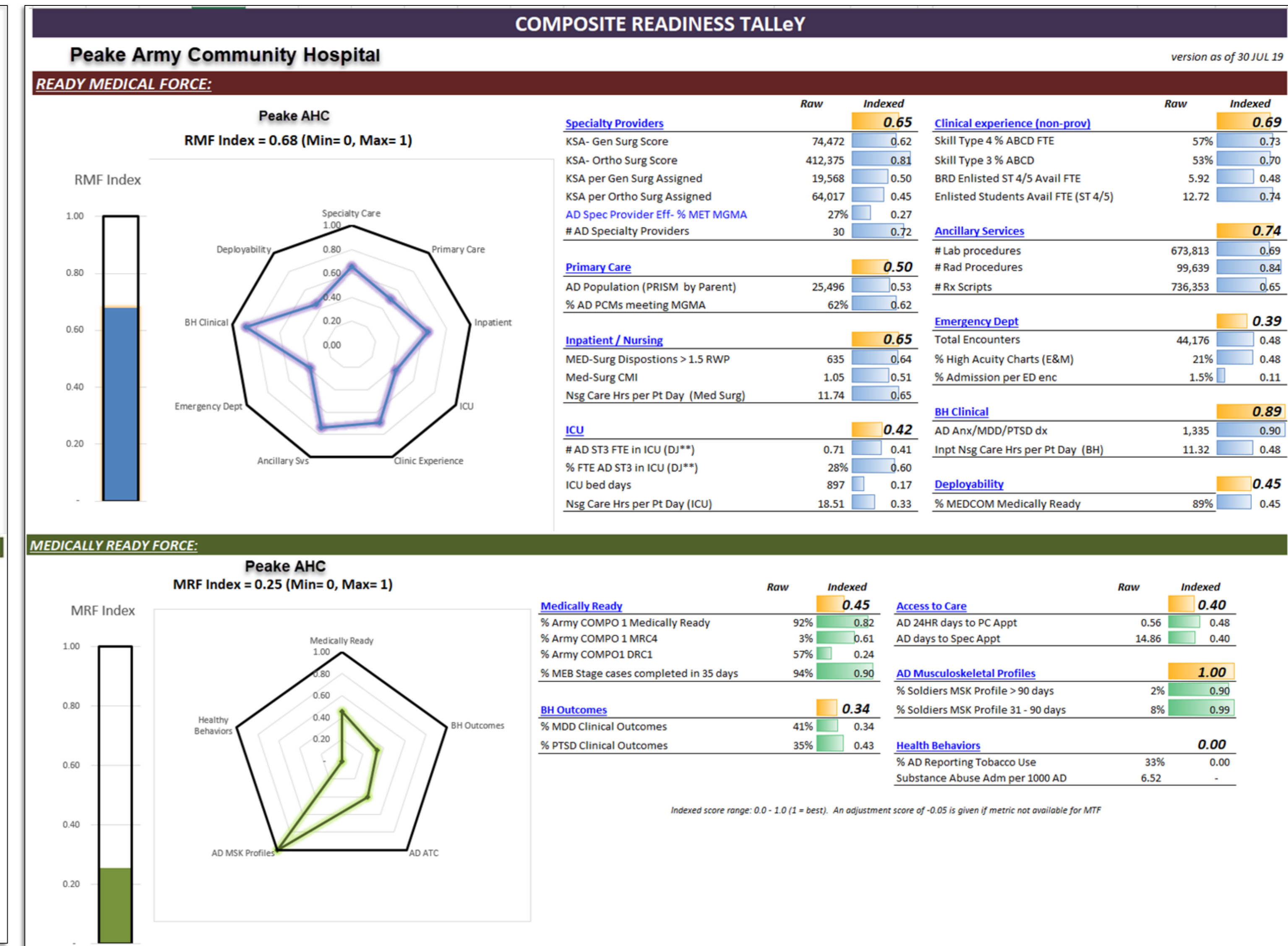
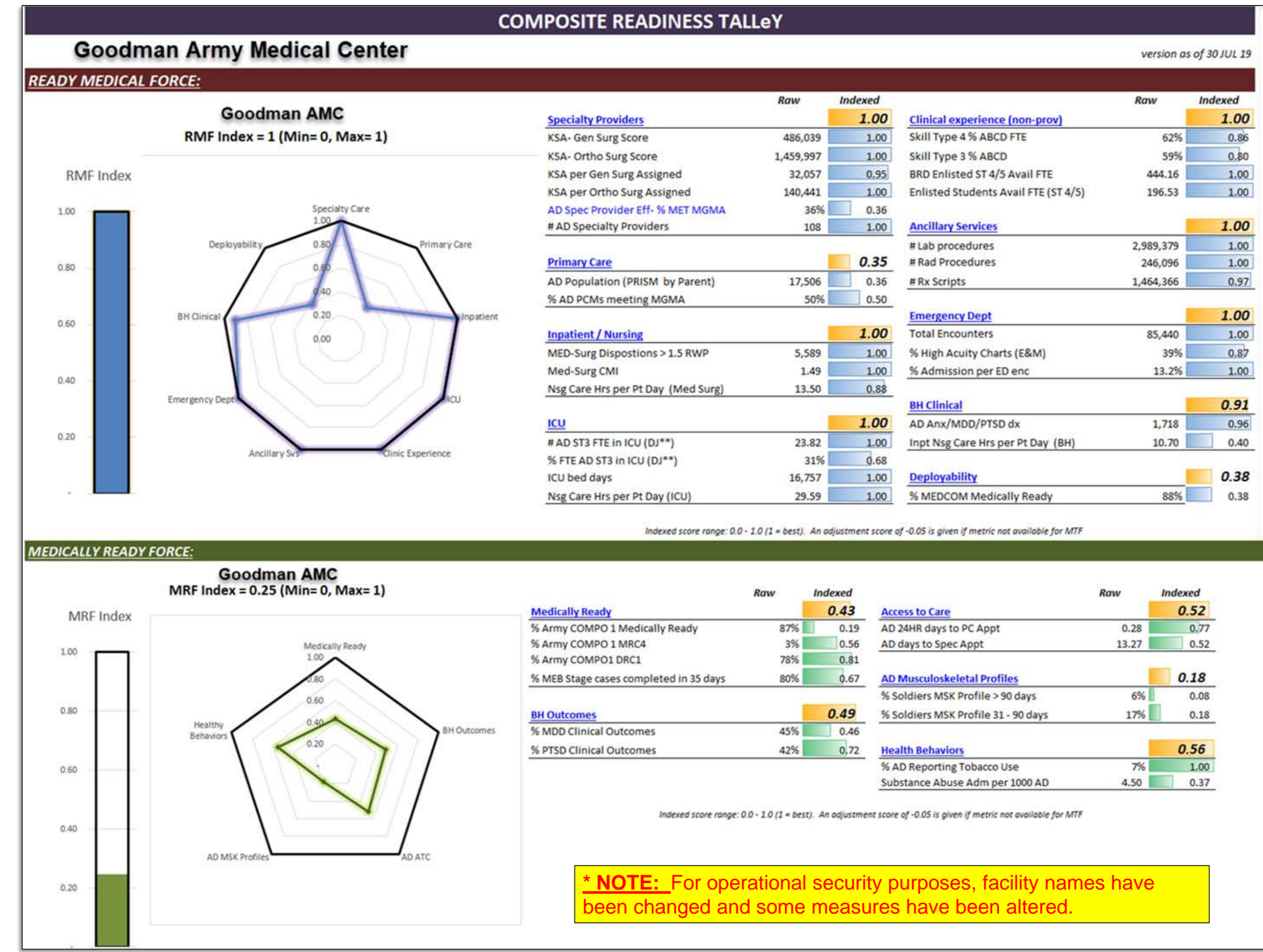


Fig 9: Dashboard displays of the Composite Readiness Talley Index for 2 select Army Medical facilities.



### References

Organization for Economic Co-operation and Development (2008), handbook on Constructing Composite Indicators.

Goodman, R., Campbell, K., et al (1998). The Economic Efficiency Factor and its use in service line evaluation. Army Medical Department Journal. July: 2-8.

The views expressed in the display are those of the authors and do not necessarily reflect the official policy of the Department of Defense, Department of the Army, US Army Medical Command, or the United States.

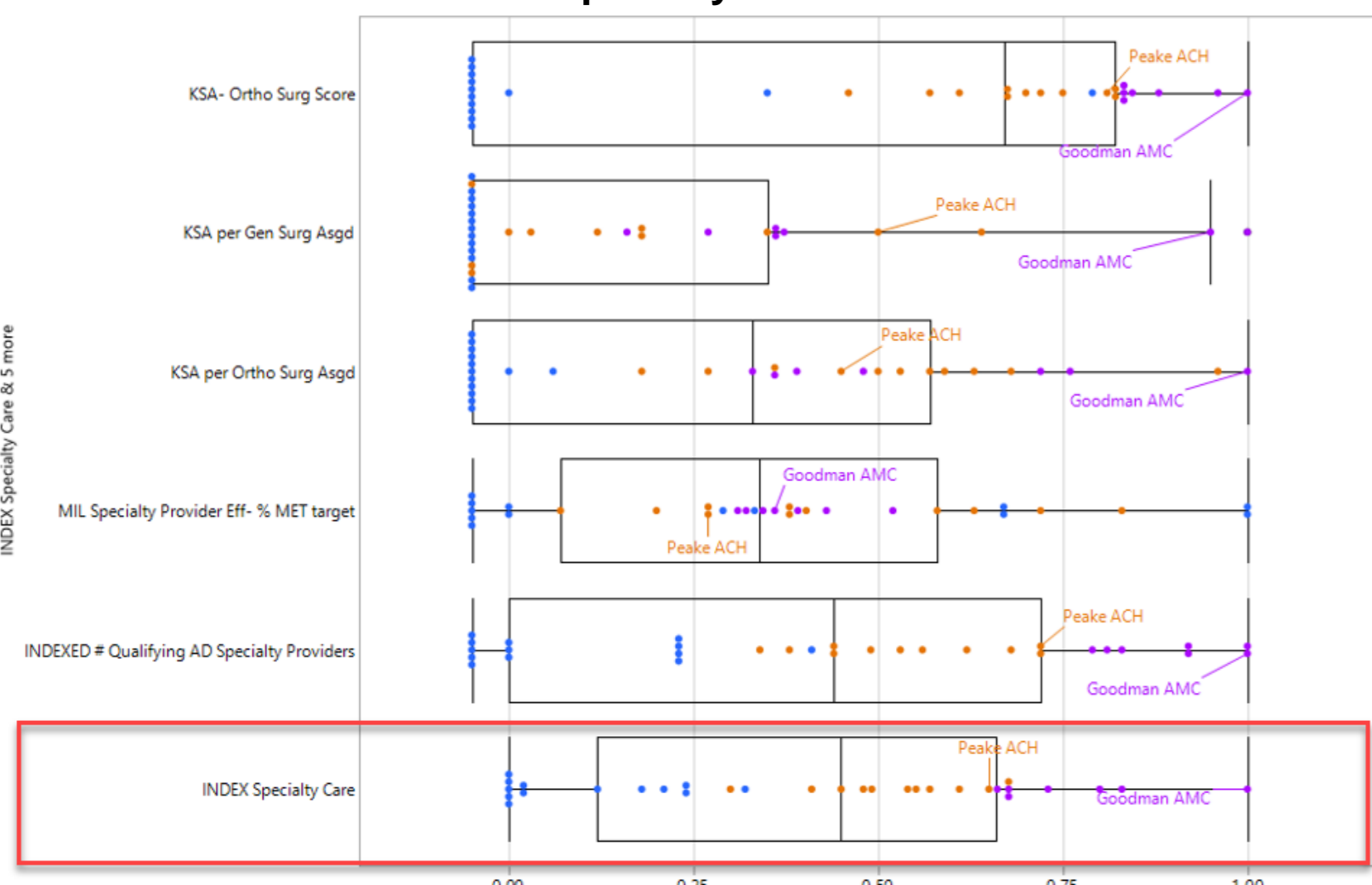
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## Index score distributions of Army Medical Facilities for select measures and Sub-groups of the “Ready Medical Force” construct. (Sub-group Composite index is highlighted in red box)

Facility Type

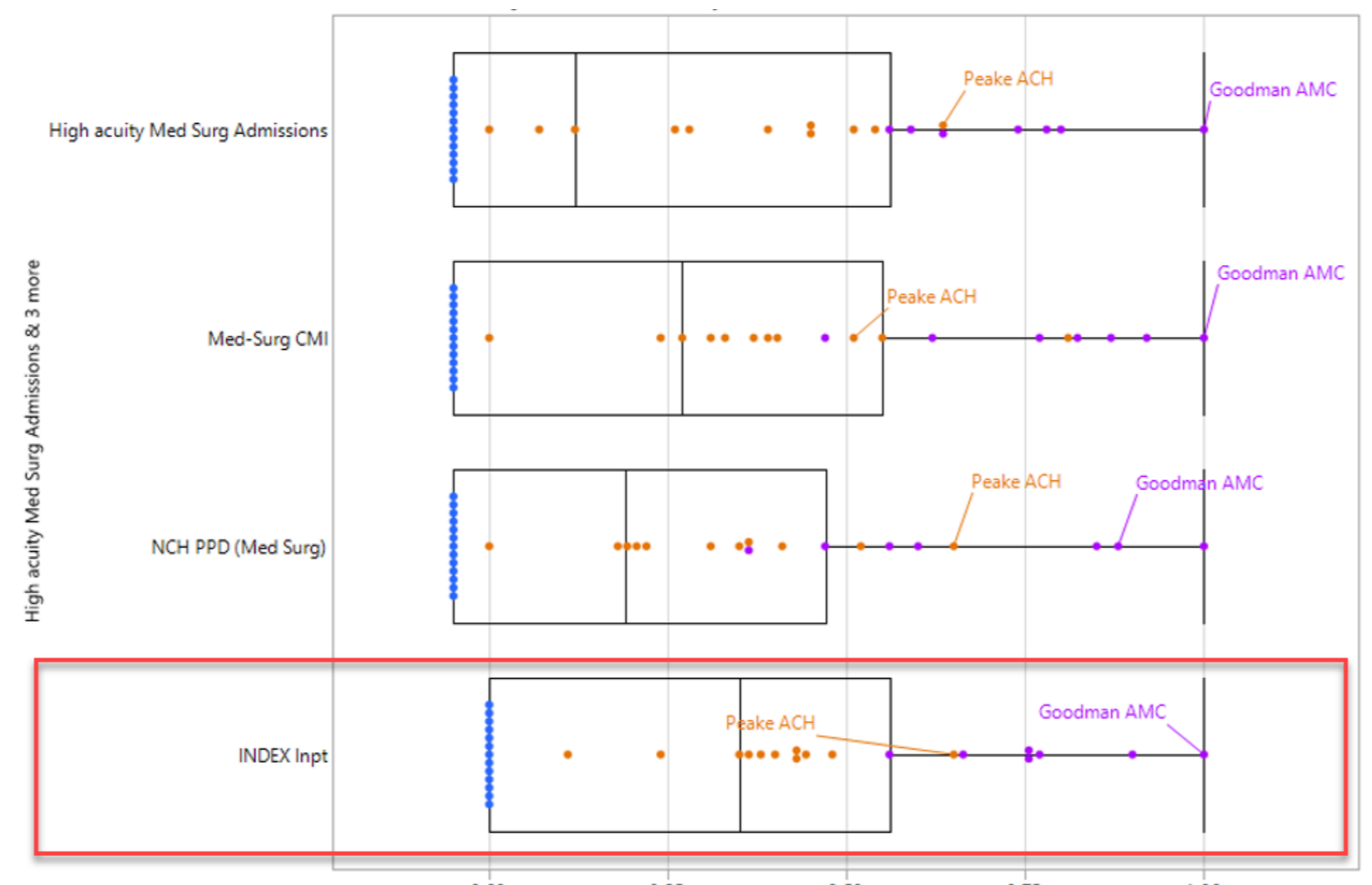
- Box Plot
- Clinic
- Hosp
- MEDCEN

### Specialty Care



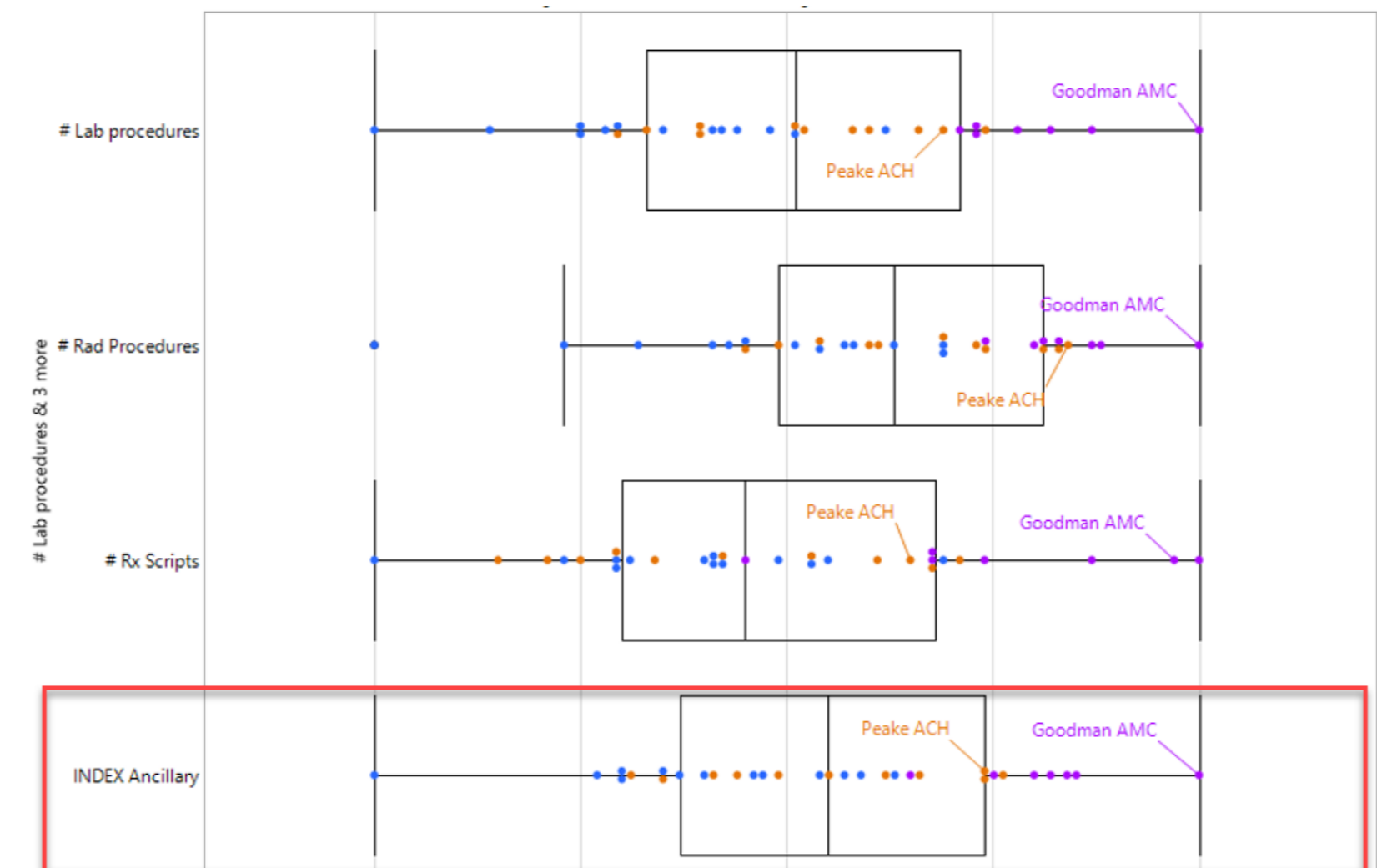
GOODMAN MEDICAL CENTER is the highest scoring facility in most Specialty Care measures. PEAKE COMMUNITY HOSPITAL ranks high among Army Hospitals (non-MEDCEN) (Component index = 0.65)

### Inpatient Care



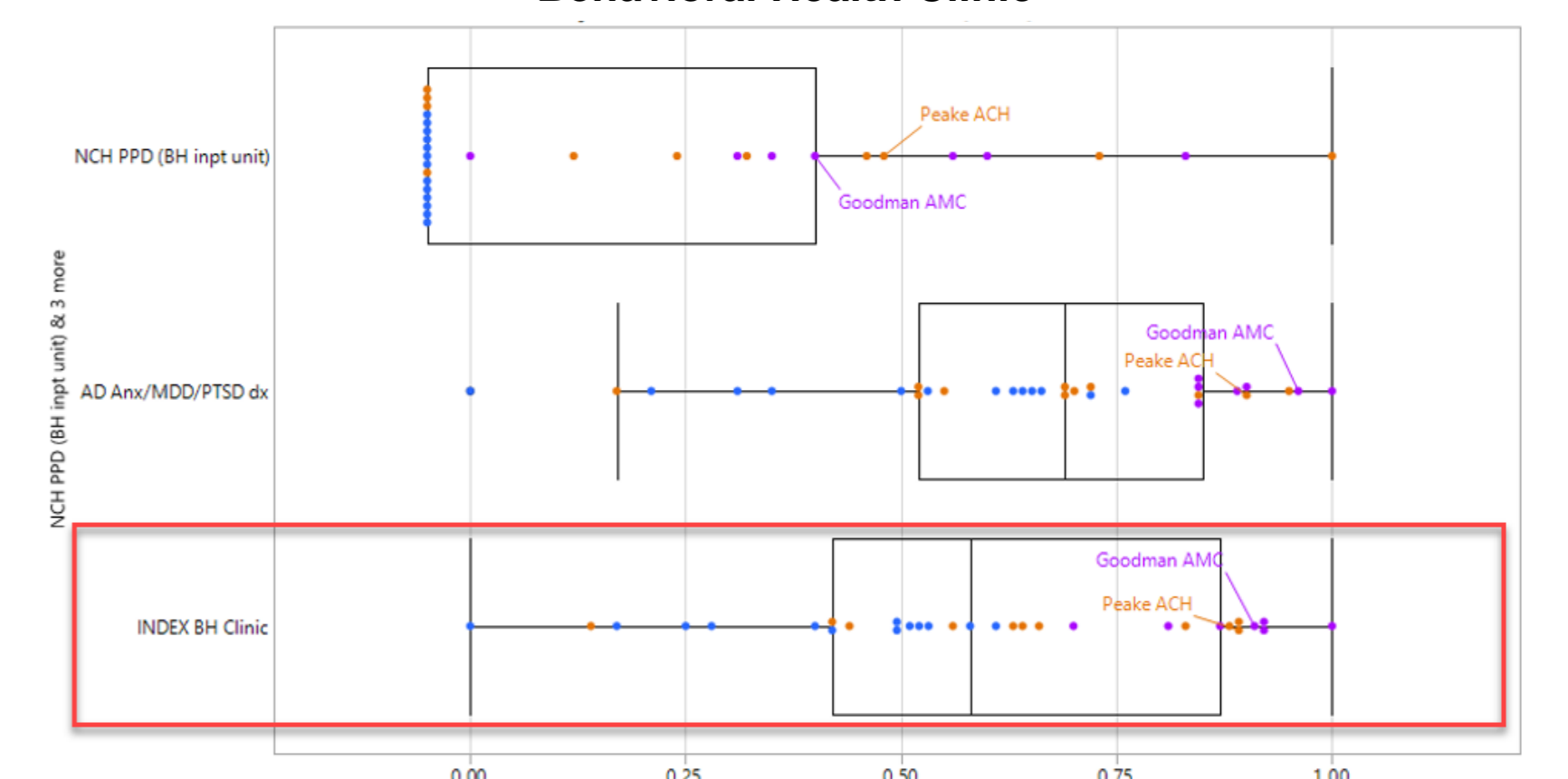
GOODMAN MEDCEN ranks highest in most inpatient measures. PEAKE COMM HOSP ranks highest among Community Hospitals (Component Index = 0.65). Note that Clinics have an index score = 0, since they do not have inpatient services.

### Ancillary Services



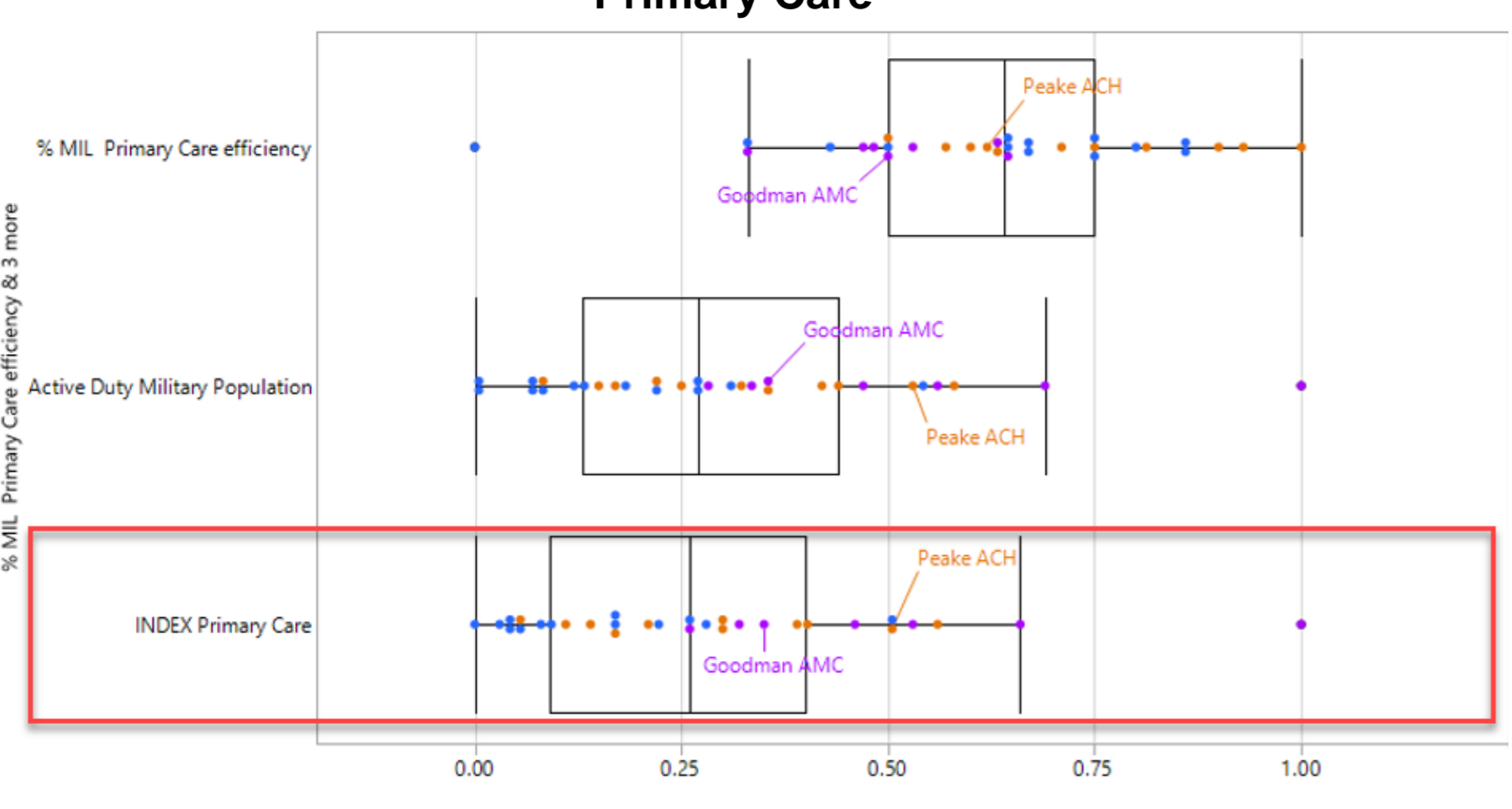
GOODMAN MEDCEN ranks highest for ancillary services (minus prescriptions). PEAKE COMM HOSP ranks above the median of all MTFs (Component Index = 0.74)

### Behavioral Health Clinic



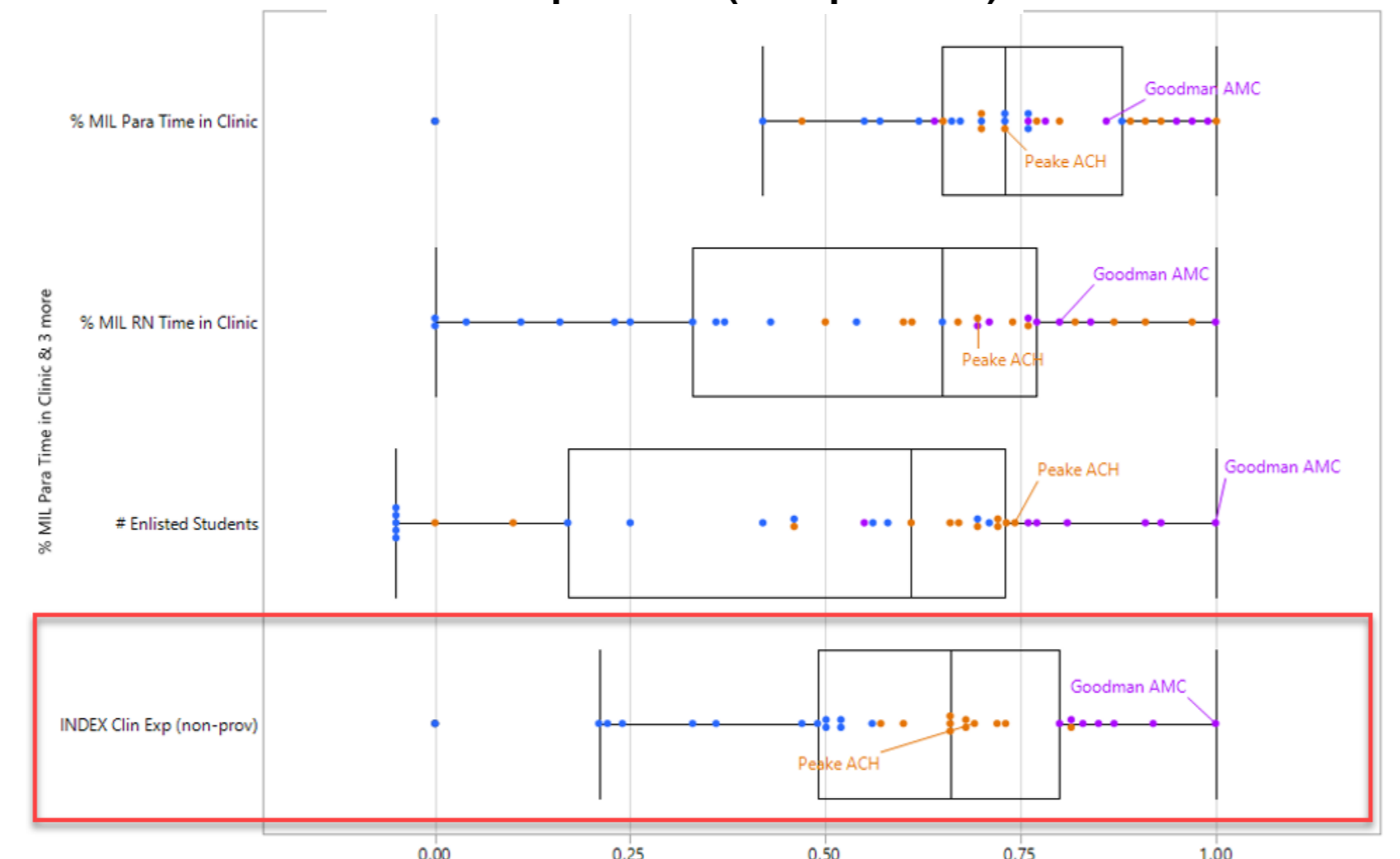
GOODMAN MEDCEN ranks alongside PEAKE COMM HOSP for Behavioral Health Clinic Experience. PEAKE has a higher BH Inpatient Unit acuity than GOODMAN. Note that many clinics are spread out across the BH Component Index scale.

### Primary Care



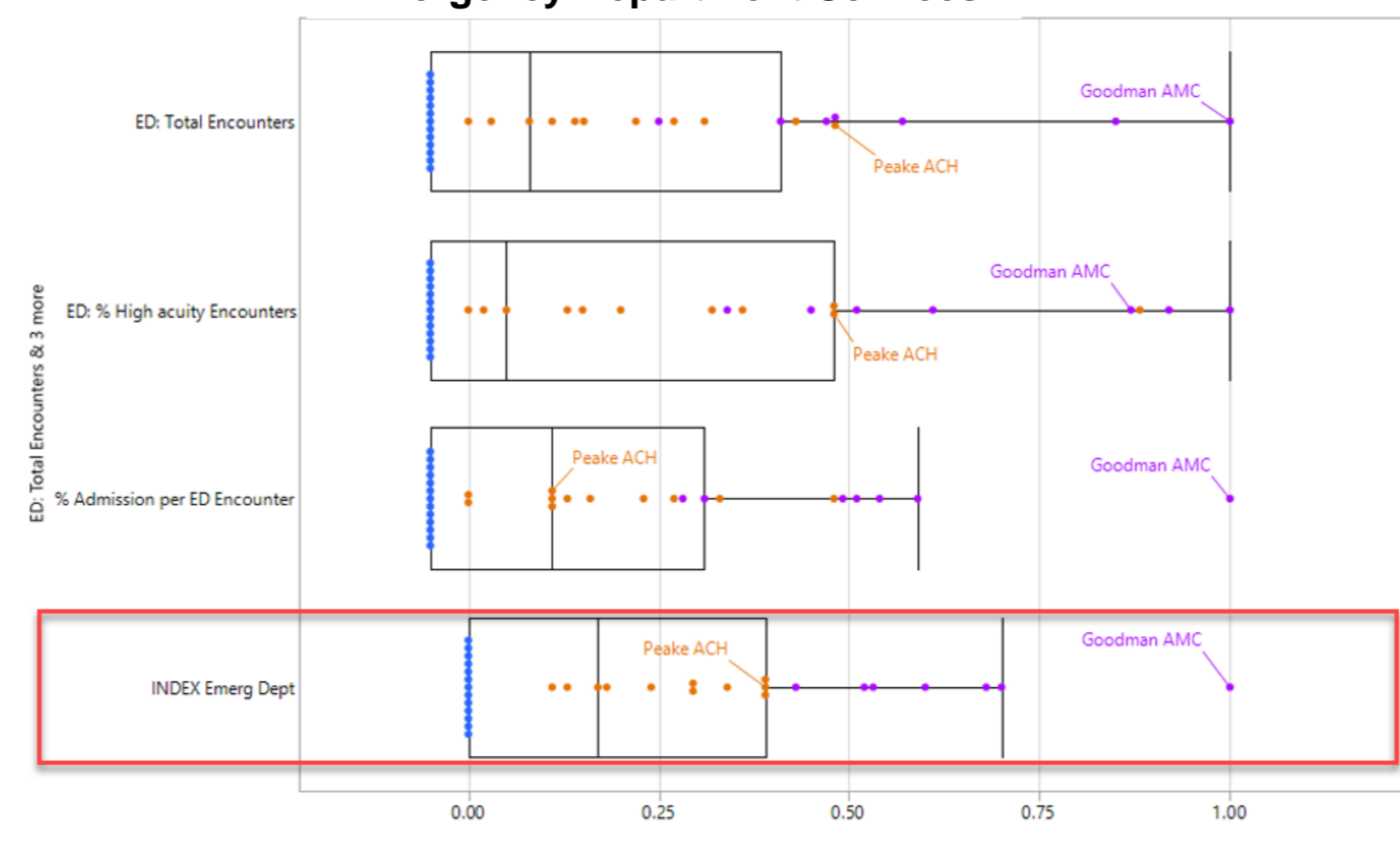
GOODMAN MEDCEN scores lower in all Primary Care measures, given it is a tertiary care center. PEAKE COMM HOSP, with a large number of Active Duty forces ranks higher than half of the Army MTFs for Primary Care clinical experience (Component Index = 0.5)

### Clinical Experience (Non-provider)



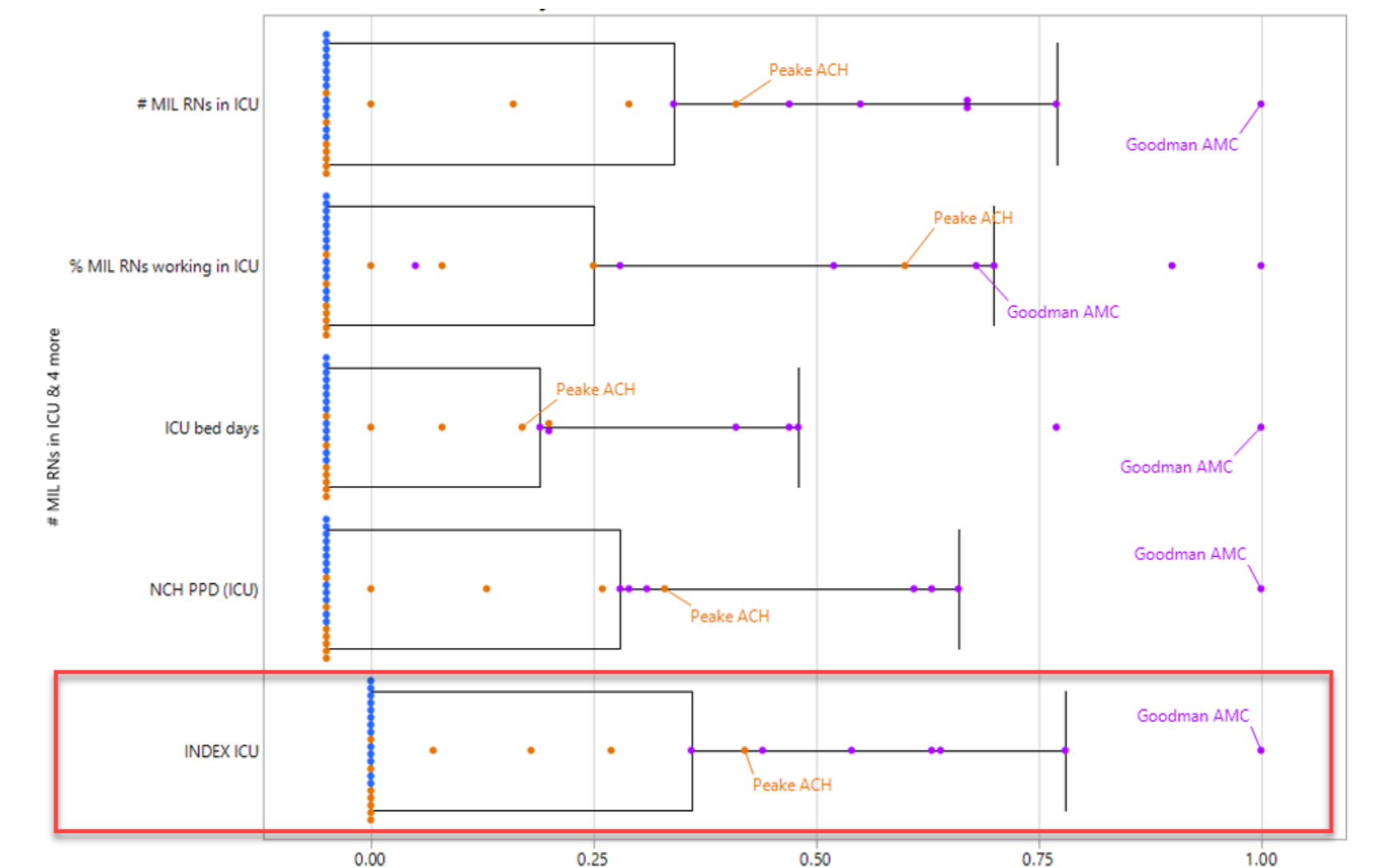
GOODMAN MEDCEN ranks highest for clinical experience— which is the site of many Phase II nursing and allied health training programs. PEAKE COMM HOSP ranks above the median of all MTFs (Component Index = 0.69)

### Emergency Department Services



GOODMAN MEDCEN ranks highest for Emergency Dept experience, it is also one of the DoD Trauma Centers. PEAKE COMM HOSP ranks above the median of all MTFs (Component Index = 0.39). Note that none of the Army Health Clinics offer Emergency Services.

### Intensive Care Units



GOODMAN MEDCEN ranks highest in most of the ICU measures. PEAKE has the highest index values among Army Community Hospital. Note that all clinics and several community hospitals do not have ICU capabilities.

This page displays the distribution of indexed measures for the 32 Army MTFs, with 2 MTF labeled for comparative purposes.

NOTE: For operational security purposes, facility names have been changed and some measures have been altered.