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OPERATIONAL TEST
AND EVALUATION

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MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND SUSTAINMENT
CHIEF INFORMATION OFFICER OF THE DEPARTMENT OF DEFENSE
ASSISTANT SECRETARY OF DEFENSE FOR HEALTH AFFAIRS
DIRECTOR, DEFENSE HEALTH AGENCY
PROGRAM EXECUTIVE OFFICER, DEPARTMENT OF DEFENSE HEALTHCARE MANAGEMENT SYSTEMS

SUBJECT: Military Healthcare System (MHS) GENESIS Initial Operational Test and Evaluation (IOT&E) Report

The attached MHS GENESIS IOT&E Report provides my evaluation of a partial IOT&E conducted at three military treatment facilities in Washington State. The Program Management Office (PMO) postponed the IOT&E at a fourth site to remediate significant problems discovered at the first three sites. The PMO plans to conduct the IOT&E at the fourth site in Fiscal Year 2018. I will release my final report following the conclusion of IOT&E.

The partial IOT&E was adequate to determine that MHS GENESIS is neither operationally effective nor operationally suitable. MHS GENESIS is not operationally effective because it does not demonstrate enough workable functionality to manage and document patient care. Users successfully performed only 56 percent of the 197 tasks used as Measures of Performance. MHS GENESIS is not operationally suitable because of poor system usability, insufficient training, and inadequate help desk support. Survivability is undetermined because cybersecurity testing is ongoing.

I recommend that the Under Secretary of Defense for Acquisition and Sustainment delay further fielding until the Joint Interoperability Test Command completes the IOT&E and the PMO corrects any outstanding deficiencies.

My point of contact for this action is Mr. Kirk Johnson. He may be reached via email at kirk.s.johnson.civ@mail.mil or at (571) 372-3831.

Robert F. Behler
Director

Attachment:
As stated

cc:
DHMSM Program Manager

Military Healthcare System (MHS) GENESIS
Initial Operational Test and Evaluation (IOT&E) Report

Executive Summary

The Department of Defense (DOD) is fielding the Military Healthcare System (MHS) GENESIS to replace electronic health record systems in the current MHS. This report provides the DOT&E evaluation of a partial Initial Operational Test and Evaluation (IOT&E) that the Joint Interoperability Test Command (JITC) conducted with support from the Service Operational Test Agencies (OTAs). JITC conducted IOT&E from September through December 2017 at three military treatment facilities (MTFs) in Washington State. In December 2017, the Program Management Office (PMO), with DOT&E concurrence, postponed the IOT&E at a fourth site to remediate significant problems discovered at the first three sites. The PMO plans to conduct the IOT&E at the fourth site in FY2018.

The PMO supported a robust series of integrated test events leading to IOT&E and has worked aggressively to address problems discovered during testing, especially those that could affect patient safety. As part of system development, the PMO worked with the DOD Chief Information Officer to conduct a series of cybersecurity assessments, then worked with the MHS GENESIS contractor to facilitate a government/contractor collaboration to improve the cybersecurity of the system and its supporting network.

MHS GENESIS is neither operationally effective nor operationally suitable. Survivability is undetermined because cybersecurity testing is ongoing. DOT&E recommends that the Under Secretary of Defense for Acquisition and Sustainment delay further fielding until JITC completes the IOT&E and the PMO corrects any outstanding deficiencies. Detailed recommendations are included in the main body of this report.

MHS GENESIS is not operationally effective because it does not demonstrate enough workable functionality to manage and document patient care. Users satisfactorily performed only 56 percent of the 197 tasks used as measures of performance. Poorly defined user roles and workflows resulted in an increase in the time required for health care providers to complete daily tasks. Some providers reported that they needed to work overtime and were seeing fewer patients per day due to delays caused by defects in MHS GENESIS.

Users questioned the accuracy of the information exchange between external systems and MHS GENESIS, which could jeopardize patient safety due to inaccurate patient medical data. Users generated 22 high severity incident reports (IRs) that the testers attributed to interoperability, including interoperability of medical and peripheral devices.

MHS GENESIS is not operationally suitable because of poor system usability, insufficient training, and inadequate help desk support. Users gave MHS GENESIS usability an average score of only 37 out of 100 on the System Usability Scale (SUS), well below the threshold of 70 that indicates acceptable usability. Training was insufficient to overcome usability problems, and a lack of documentation forced users to develop their own operational workarounds. User survey comments from the three IOT&E sites reported similar problems that

included undocumented and inconsistent workarounds, excessive system latency, inaccurate patient information, badly assigned user roles, poor user training, uneven assistance from on-site trainers, and lack of visibility of the status of trouble tickets. Users from the four initial sites submitted 14,383 help desk tickets from January to November 2017, overwhelming the help desk's ability to resolve them.

System outages indicated that the end-to-end system and supporting network did not have sufficient availability to support operations at the four IOT&E MTFs. Users reported increased lag times when other IOT&E sites went live, suggesting the current system and supporting network configuration will not support the hundreds of additional sites planned for MHS GENESIS.

System Description and Mission

The DOD Healthcare Management System Modernization (DHMSM) program is acquiring MHS GENESIS to replace multiple legacy systems – such as Armed Forces Health Longitudinal Technology Application (AHLTA), the Composite Health Care System (CHCS), and Essentris – with a commercial off-the-shelf, integrated Electronic Health Record (EHR) software system to deliver and document healthcare services at all fixed facility locations worldwide. MHS GENESIS is centrally hosted at the Cerner Technology Center in Kansas City, Missouri. The PMO plans to field MHS GENESIS to 250,000 MHS personnel who provide care for 9.6 million DOD beneficiaries. The locations include all garrison MTFs, comprising more than 650 hospitals and clinics.

DOD medical staff use MHS GENESIS to manage delivery of en-route care, dentistry, emergency department, health, immunization, laboratory, radiology, operating room, pharmacy, vision, audiology, and inpatient/outpatient services. DOD medical staff also use the EHR system to perform administrative support, front desk operations, logistics, billing, and business intelligence. The software consists of three major elements: (1) the Cerner Millennium suite of applications, which provides clinical and administrative capabilities; (2) Dentrix, developed by Henry Schein Inc., which provides dental capabilities; and (3) Orion Rhapsody, the framework that enables most of the external information exchanges. The MTFs transport information via the Non-classified Internet Protocol Router Network using the DISA Medical Community of Interest Virtual Private Network.

Test Conduct and Adequacy

The IOT&E is not yet complete, but the partial IOT&E was adequate to determine that MHS GENESIS was neither operationally effective nor operationally suitable. JITC conducted IOT&E at Fairchild Air Force Base (FAFB) and Naval Health Clinic Oak Harbor (NHCOH) from September 25 to October 6, 2017 and Naval Hospital Bremerton (NHB) from December 4-15, 2017. Following the Bremerton IOT&E, the PMO postponed the Madigan Army Medical Center (MAMC) IOT&E to remediate significant problems discovered at the first three sites. The PMO plans to conduct the IOT&E at MAMC in FY2018. DOT&E will release a final IOT&E Report following the conclusion of MAMC testing. JITC conducted IOT&E with

Service OTA assistance and in accordance with the DOT&E-approved IOT&E Plan. DOT&E observed two phases:

- Go-Live (initial deployment) activity at four MTFs and the administration of user surveys
- System operations in the live environment at FAFB, NHCOH, and NHB

During the IOT&E, healthcare providers, technicians, and administrators performed their day-to-day tasks while JITC observed their performance and noted the success or failure of each attempt. Morae video screen capture instrumentation provided information to identify system and user errors. The users and JITC prepared IRs to document problems. A Data Authentication Group (DAG), composed of users and testers, convened to formally adjudicate each IR. JITC collected data on interoperability where it was available, and administered user surveys on training, usability, and other suitability areas. Cybersecurity testing is ongoing. DOT&E will determine survivability when testing is complete.

Leidos Partnership for Defense Health (LPDH), the system contractor, and the DHMSM PMO established a command center at each MTF as MHS GENESIS went live to monitor and provide support for system users. LPDH provided Adoption Coaches, subject matter experts who offered over-the-shoulder support to users as they worked with MHS GENESIS. Nearly all users received formal training on the system before it went live at their MTF. The training included classroom and computer-assisted training.

JITC conducted part of a Cooperative Vulnerability and Penetration Assessment (CVPA), the first segment of cybersecurity operational testing. JITC separated the CVPA into three phases: (1) testing of the system hosted at the Cerner Technology Center, (2) testing of interfacing medical devices at the Fixed Facility Government Approved Laboratory, and (3) testing of the end-user environment at MAMC.

JITC has completed the first phase. The Space and Naval Warfare Systems Command (SPAWAR) Red Team executed testing for JITC on site from December 4-15, 2017. JITC and the PMO extended the CVPA testing to allow for a thorough evaluation of the system. SPAWAR executed additional testing of the Cerner Technology Center from January 16 to February 8, 2018. The PMO plans to complete cybersecurity testing in FY2018.

DOT&E considered three Critical Operational Issues (COIs) when evaluating operational effectiveness (COI 1 and COI 2) and operational suitability (COI 3):

- COI 1: Healthcare Management – Does MHS GENESIS provide the capabilities to manage and document health-related services?
- COI 2: Interoperability – Do MHS GENESIS interfaces support or enable accomplishment of mission activities and tasks?
- COI 3: Suitability – Does MHS GENESIS usability, training, support, and sustainment ensure continuous operations?

Test Limitations

While the IOT&E was adequate to determine operational effectiveness and suitability, it had the following limitations:

- JITC could not complete the IOT&E with four sites as originally planned because the PMO, DOT&E, and JITC postponed testing at MAMC to allow time to improve system/network availability, reengineer workflows, improve training, and implement a scheduled Cerner Millennium upgrade. JITC could not fully evaluate MHS GENESIS functionality because MAMC is the largest test facility, with clinics and functionality not utilized at other sites.
- MAMC resisted use of medical center facilities for Red Team cybersecurity testing. An adequate assessment of MHS GENESIS survivability will require operational testing at MAMC or a similar MTF.
- The need to protect patient privacy inhibited direct observation of healthcare providers performing their mission. JITC mitigated this limitation through user interviews and use of the Morae screen-capture tool.
- JITC did not have sufficient end-to-end data on information accuracy and completeness to fully evaluate interoperability with external systems. Additional interoperability testing is required to ensure MHS GENESIS can properly interface with legacy DOD systems to support medical missions.
- The PMO did not furnish reliability and availability data, so evaluators could not determine system reliability and availability. The PMO is working on methods to gather this information from live sites, interfacing partners, and the network infrastructure in an attempt to mitigate the problem.

Operational Effectiveness

MHS GENESIS is not operationally effective because it does not contain enough functionality to manage and document patient care. Users successfully performed only 56 percent of the 197 tasks used as Measures of Performance (MOPs). Non-standard data and the failure to adhere to Interface Control Documents (ICDs) hampered information exchange with interfacing systems. DOT&E used COI 1 and COI 2 to determine operational effectiveness.

Healthcare Management

DOT&E assessed operational effectiveness primarily from demonstrated user mission accomplishment. The test plan documented 21 Measures of Effectiveness (MOEs) to assess Healthcare Management. These MOEs aligned generally with the medical areas, clinics, logistics, and administration (e.g., dentistry, pharmacy, emergency, front desk) of an MTF. Satisfying an MOE is an indication that the system met the mission needs in its respective area. The 21 MOEs decomposed into 241 MOPs (e.g., manage vaccine records, view specimens, admit patients) that could be tested individually. During the course of the IOT&E, testers filled out or collected data sheets when direct observation was not possible, while users attempted to

perform their daily tasks and matched them up with MOPs. The testers interviewed the users to determine success or failure of their tasks and consulted screen capture information remotely to evaluate failures.

The test team tested 197 MOPs, which allowed for full evaluation of 17 of the 21 MOEs. Table 1 shows resolution of MOPs within each MOE. The testers were unable to evaluate 10 MOPs because the functionality did not exist at FAFB, NHCOH, and NHB. JITC did not test an additional 34 MOPs because the PMO deferred these functionalities after consulting with senior user representatives from each of the Services. JITC observed users interacting with the system, either over the shoulder or remotely, and tallied the successes and failures of actions associated with each MOP.

When the users were unable successfully to complete a task (MOP), the testers assisted them in submitting an IR to document the problem. A DAG scored each IR in accordance with established rules and definitions. Priority 1 – Critical represented the highest severity level and Priority 4 – Minor represented the lowest.[1] Table 1 also shows the number of high-severity (Priority 1 and 2) IRs associated with each MOE. The majority of the MOEs (18 of 21, 86 percent) had at least one high-severity deficiency that affected mission completion.

Evaluators considered MOPs with at least a 90 percent success rate and no high-severity IRs as "met." As shown in Table 1, 110 of the 197 MOPs tested (56 percent) met test criteria and 87 (44 percent) did not. The success rate of the MOPs and high-severity IRs were aggregated across the MOEs. While the functionality was not sufficient to fully satisfy any of the MOEs, evaluators, subject matter experts, and users determined whether the system provided some of the functionality within the MOE. Of the 17 MOEs that the testers fully evaluated, 14 (82 percent) were "not satisfied" because users were not able to execute a majority of the functionality and each had at least one high-severity deficiency. The remaining three (18 percent) MOEs were "partially satisfied" because users were able to execute some of the functionality; however, more data is required to fully evaluate the MOE. An additional three MOEs could not be fully evaluated because the functionality exists within the Initial Operational Capability (IOC) sites only at MAMC. Functionality within the remaining MOE is deferred to the theater capability.[2]

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[1] Priority 1 – Critical designates a mission failure that prevents the accomplishment of an essential capability. These incidents may also jeopardize patient safety. Priority 2 – Major designates a partial mission failure that adversely affects the accomplishment of an essential capability for which there is no known, documented workaround solution. Priority 3 – Moderate designates a substantial degradation of mission-related capabilities that adversely affects the accomplishment of an essential capability for which there is a documented workaround solution. Priority 4 – Minor designates a noticeable problem, but no major interference with mission accomplishment.

[2] The Joint Operational Medicine Information System PMO will deploy the MHS GENESIS system in theater.

Table 1. Results of the DHMSM MOE and MOP Testing at FAFB, NHCOH, and NHB

MOE	Title	*MOP Evaluation*							MOE Status
		Total MOPs	Deferred	Not Tested	Tested and Met	Tested and Not Met	% Tested MOPs Met	# Priority 1 or 2 IRs	
1.1	En Route Care	8	5	3	0	0	0%	0	Not Evaluated[1]
1.2	Dentistry	10	1	0	3	6	33%	3	Not Satisfied
1.3	Emergency Department	3	0	0	3	0	100%	0	Not Fully Evaluated[2]
1.4	Health Services	23	1	2	13	7	65%	7	Not Satisfied
1.5	Immunization Services Management	7	0	0	2	5	29%	11	Not Satisfied
1.6	Laboratory Services Management	14	0	1	2	11	15%	12	Not Satisfied
1.7	Operating Room Services Management	3	0	0	3	0	100%	0	Not Fully Evaluated[3]
1.8	Pharmacy Services Management	15	0	0	11	4	73%	8	Not Satisfied
1.9	Vision Services Management	7	0	0	5	2	71%	2	Partially Satisfied
1.10	Inpatient/Outpatient Services Management	25	0	3	19	3	86%	1	Not Fully Evaluated[3]
1.11	Administrative Support Management	7	4	0	2	1	67%	1	Not Satisfied
1.12	Front Desk Operations	4	0	0	3	1	75%	1	Partially Satisfied
1.13	Logistics Management	9	2	0	6	1	86%	2	Partially Satisfied
1.14	Business Intelligence Management	25	7	0	13	5	72%	7	Not Satisfied
1.15	Facility View Support	2	1	0	0	1	0%	2	Not Satisfied
1.16	Report Generation	28	9	0	8	11	42%	20	Not Satisfied
1.17	Case Management	8	0	0	6	2	75%	1	Not Satisfied
1.18	PHR Portal Management	3	1	0	0	2	0%	1	Not Satisfied
1.19	Disconnected User Operations	3	0	0	0	3	0%	6	Not Satisfied
1.20	Common User Tasks	32	2	1	9	20	31%	78	Not Satisfied
1.21	Radiology Services Management	5	1	0	2	2	50%	2	Not Satisfied
Overall		***241***	***34***	***10***	***110***	***87***	***56%***	***--[4]***	**--**

[1] En Route Care deferred to the Joint Operational Medicine Information System.
[2] FAFB, NHCOH, and NHB did not have Emergency Departments. Samples shown were collected in Urgent Care Clinics.
[3] FAFB, NHCOH, and NHB did not have inpatient services. All samples are from outpatient only.
[4] IRs may apply to more than one MOE, therefore the sum of this column is not the total number of Priority 1 and 2 IRs affecting Health Care Delivery.
Green text indicates "satisfied," **red** text indicates "not satisfied"
DHMSM – DOD Healthcare Management System Modernization; MOE – Measure of Effectiveness; MOP – Measure of Performance; FAFB – Fairchild Air Force Base; NHCOH – Naval Health Clinic Oak Harbor; NHB – Naval Hospital Bremerton; IRs – Incident Reports; PHR – Personal Health Record

Users at the three IOT&E sites submitted 208 IRs that affected the areas of Healthcare Management (COI 1), Interoperability (COI 2), and Suitability (COI 3). Figure 1 shows that a large majority of these (156 IRs, 74 percent) were Priority 1 or Priority 2 severity reports. The users felt that most of the critical deficiencies were potential patient safety concerns. Site leadership continues to meet daily with staff to identify potential patient safety concerns, which they quickly elevate to the PMO for action.

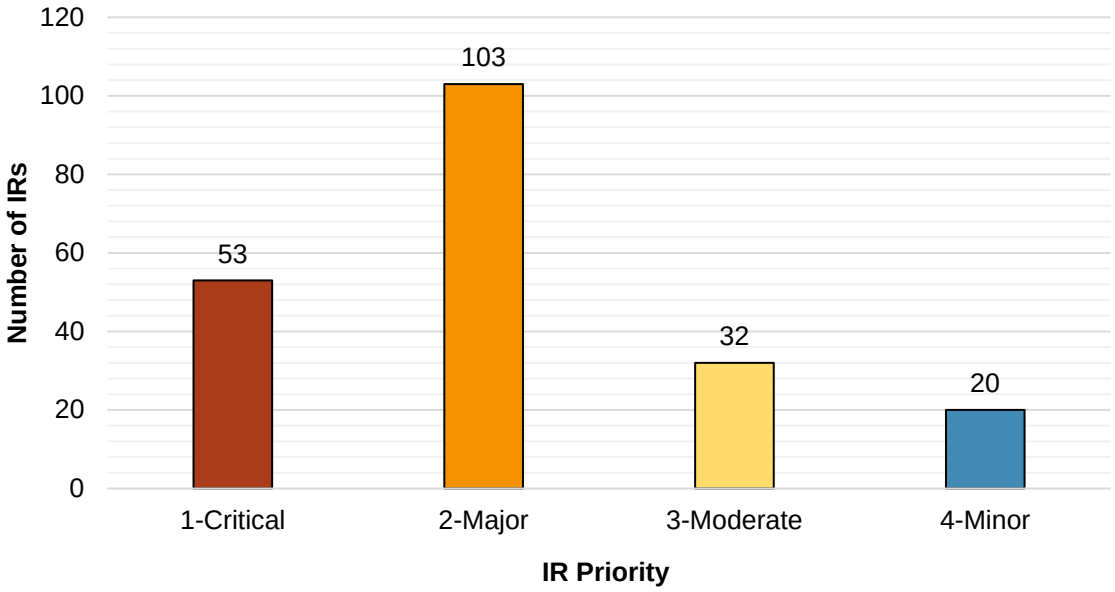


Figure 1. Incident Reports (IRs) by Priority

Essential capabilities were either not working properly or were missing altogether (e.g., referral requests not processing, lab results not showing, oral surgery apps not launching). To compensate for missing functionality, users relied on lengthy and undocumented workarounds (e.g., telephoning to check whether referrals had been received). Additionally, ineffective or non-existent workflows (e.g., the inability to flag certain patient records, insurance eligibility inaccuracies, appointments tracked to the wrong clinic) caused some users to create their own workarounds. Actions that used to take one minute to complete were taking several minutes using MHS GENESIS. Users reported that, even under conditions of proper functionality, actions required up to three times as many mouse clicks than before. User comments accompanying the IRs and user interviews indicate that MHS GENESIS increased patient encounter times to the point that providers were seeing fewer patients per day, despite some providers working overtime.[3] Users also noted operational incidents (e.g., system freezes, lockouts, login errors) that caused mission failure or delay.

Pharmacists, in particular, found the system difficult to use. They were working extended hours due to longer prescription order workflows. Pharmacies averaged fill times of 45 minutes or more for prescriptions that previously averaged 15 to 20 minutes. Pharmacists had

[3] Patient encounter time is defined as the interaction time between a patient and healthcare provider for the purpose of providing healthcare service(s) or assessing the health status of the patient.

to employ manual processes to fill orders due to interface problems. MHS GENESIS does not support National Provider Identification numbers or National Drug Codes, forcing pharmacists to do manual searches for medications to dispense.

Users often suffered from unacceptably long MHS GENESIS login times, particularly dental providers. Login times were inconsistent, ranging from 3 to 20 minutes. Users reported their first login of the day usually took the longest. MHS GENESIS system timeouts and users having to change user roles further exacerbated the problem.

Providers often obtained user roles inappropriate to their jobs because that was the only way they could access all the functionality they needed. This allowed some users access to information and functionality they should not have had access to.

Interoperability

Interoperability is critical for MHS GENESIS to accurately transfer data to and from legacy DOD systems, such as the Defense Eligibility Enrollment System (DEERS) that ascertains eligibility for DOD medical benefits. Testers based the interoperability assessment on an analysis of conformance to the ICDs and the identified standards, IRs related to interoperability, and observations of user actions and user interviews. They did not receive end-to-end data from either MHS GENESIS or external interfacing systems, and therefore could not fully evaluate the accuracy and completeness of data exchanges.

JITC examined 25 external interfaces: 13 at FAFB and NHCOH, 11 at NHB, and 1 at all three locations.[4] While the end-to-end testing was limited, it did establish that the network between MHS GENESIS and external interface partners was sufficient for accurate messaging at the three IOT&E sites, although there were times when retransmission was required to receive successful acknowledgements. Data sent from MHS GENESIS either did not conform to its ICDs, did not conform to the applicable standards, or did not conform to both for any of the evaluated outbound interfaces. Failure to conform to standards and controls can result in failure to communicate due to improper parsing, truncation, incorrect encoding, or loss of data. This causes users to question the accuracy of the information they receive and can lead to a time-consuming check of information from other sources.

Users generated 22 high-severity IRs that the testers attributed to interoperability. These IRs describe multiple problems with accuracy and completeness that prevented or degraded mission completion. The problems included confliction with identified standards, undefined values and characters, undefined data types, undefined extra fields, unpopulated data fields, and other discrepancies. The IRs affected Personnel Eligibility and Enrollment, Military Medical Readiness, Radiology, and information exchange with Defense Medical Information Exchange (DMIX) and the Joint Legacy Viewer (JLV).

- Personnel Eligibility and Enrollment. DEERS is one of the main MHS GENESIS external interfaces, and users observed patient identification and safety problems with

[4] JITC tested one interface, Medical Readiness System Agile Core Service-Data Access Layer, at all three locations. JITC tested 21 external interfaces that had data exchanges; the remaining 4 were visual only.

it (e.g., date of birth data discrepancies). Healthcare operations are sensitive to the age of the patient, particularly with newborns, and inaccurate data can create patient safety concerns. The PMO worked rapidly to address this problem.

- Military Medical Readiness. Several IRs written against the Immunization MOE pertained to ICD and standards conformance. MHS GENESIS displayed incorrect patient immunization data and immunizations did not populate in the appropriate Medical Readiness System.
- Radiology and Imaging. Messages relating to Radiology interfaces did not conform to standards and ICDs. Radiologists could not associate results with patient records, so providers were unable to review radiology results.
- DMIX/JLV. DMIX/JLV bridges the gap between EHR documentation in MHS GENESIS and legacy healthcare systems. DMIX/JLV is the only way for users of the legacy systems to view encounters documented in MHS GENESIS. However, critical Problems, Allergies, Medications, Procedures, and Immunizations data generated in MHS GENESIS did not always display in JLV to legacy system users. If not addressed, this problem will become more severe as the amount of data stored in MHS GENESIS increases.

JITC tested interoperability of medical and peripheral devices by noting the accuracy and completeness of data transfers with MHS GENESIS. The testing was inconclusive because of the limited number of devices evaluated and the small sample sizes associated with those that were evaluated. JITC will continue evaluating these devices during the continuation of IOT&E at MAMC.

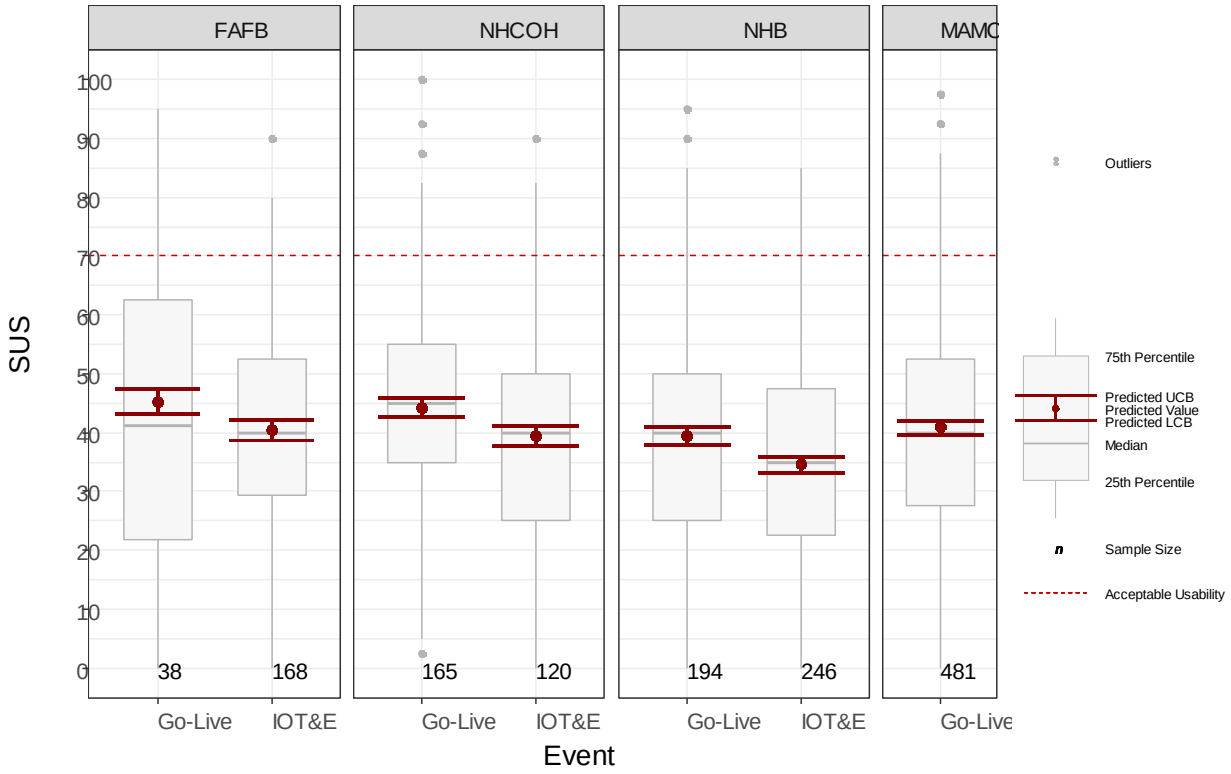
Operational Suitability

MHS GENESIS is not operationally suitable. Users rated system usability as "not acceptable" and their ratings decreased between Go-Live and IOT&E, indicating, contrary to expectations, that more experience with the system did not improve usability. Training and system documentation were insufficient to overcome usability problems and sustain operations. DOT&E used COI 3 to determine operational suitability.

Usability, Training, and Workload

Overall, users rated the usability of the system as "not acceptable" through the SUS survey.[5] The mean SUS score across the three sites during IOT&E was 37. As shown in Figure 2, the mean SUS score decreased by an estimated 5 points between Go-Live and IOT&E at each site.

[5] The SUS is a standard tool that provides a measure of usability ranging from 0 to 100. Evaluators consider scores above 70 to be acceptable.



DOT&E constructed a linear model that predicted the SUS score as a function of the event (Go-Live or IOT&E) and site, which were both significant predictors (*p* is less than 0.001 for both).

FAFB – Fairchild Air Force Base; NHCOH – Naval Health Clinic Oak Harbor; NHB – Naval Hospital Bremerton; MAMC – Madigan Army Medical Center; SUS – System Usability Scale; UCB – 80 percent Upper Confidence Bound; LCB – 80 percent Lower Confidence Bound; IOT&E – Initial Operational Test and Evaluation

Figure 2. SUS Scores from Go-Live and IOT&E Events

Users rated the training as poor. Most users (67 percent, 265 of 394) indicated during the IOT&E events that they needed more training. JITC administered a 15-question training survey – which included one question asking if users felt they needed more training – during both the Go-Live and IOT&E events. Figure 3 shows the combined results of the training survey, where 1 indicates non-favorable responses and 6 indicates favorable responses.[6] As shown, the responses were generally not favorable, and user ratings of training decreased between the Go-Live and IOT&E. This implies that as users attempted more tasks, they increasingly felt the training did not prepare them. The poor training exacerbated problems that users encountered with the system functionality.

[6] DOT&E measured internal reliability consistency between the questions in the training survey using Cronbach's alpha. A Cronbach's alpha of 0.70 or above is considered acceptable internal reliability. Results demonstrated an alpha of 0.86 for Go-Live responses and 0.89 for IOT&E responses.

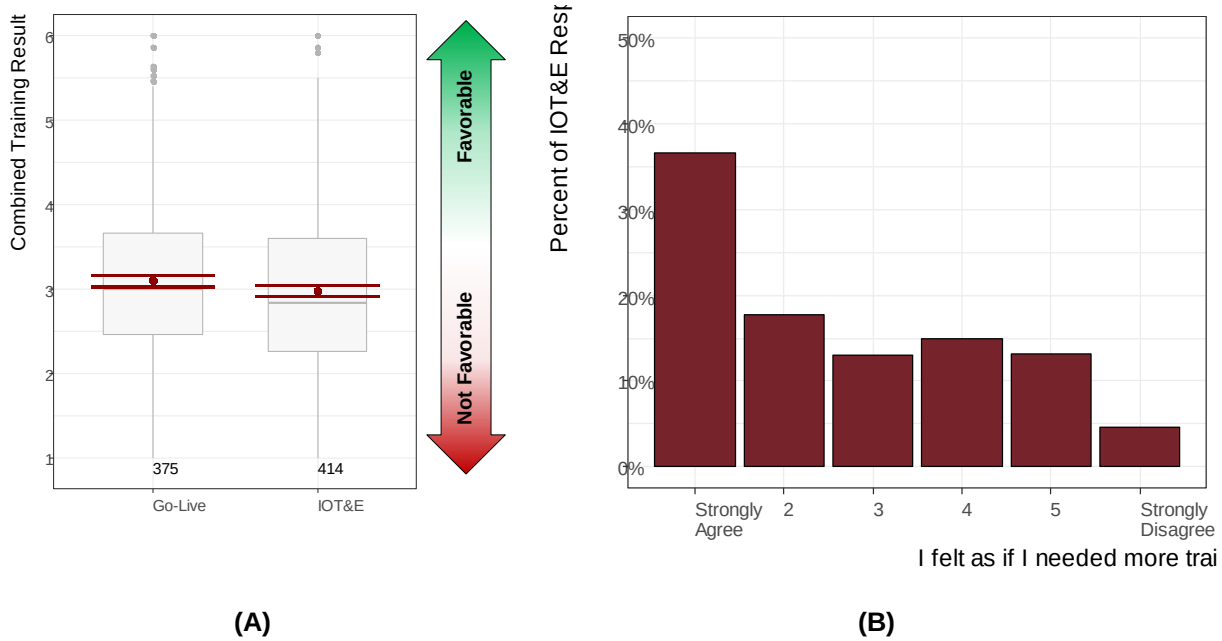


Figure 3. Training Survey Results: (A) Combined results from Go-Live and Initial Operational Test and Evaluation (IOT&E) Events and (B) IOT&E Responses on the Need for More Training

The MHS GENESIS contractor provided Adoption Coaches for over-the-shoulder user guidance and training. However, the Adoption Coaches did not always have sufficient knowledge or training to support the users following Go-Live at each site. They maintained a large footprint at the MTFs immediately following Go-Live, a footprint that, as planned, decreased steadily after the first 2 weeks at each site. The Adoption Coaches received similar training to the users, and therefore were not familiar with all aspects of the system, particularly those specific to the DOD workflows. This led to inadequate Adoption Coach support in these areas.

MHS GENESIS exhibited usability problems that the training could not overcome. If the system is usable, only poorly trained people should have usability problems. However, after accounting for training, usability still significantly predicted workload.[7]

Reliability and Availability

System outages during the Go-Lives and IOT&E indicate that the end-to-end system does not have sufficient availability. Without connectivity to the Cerner Technology Center, users cannot access MHS GENESIS, and therefore cannot document care in the system, which can bring operations to a standstill. Table 2 shows the dates and durations of seven outages JITC observed that occurred within the 5-week window of the events.

7 A linear model predicting Crew Status Survey (CSS) results as a function of SUS scores showed that usability is a significant predictor of CSS ($p < 0.001$). A separate linear model predicting CSS as a function of training scores showed that training is also a significant predictor of CSS ($p = 0.019$). However, when accounting for both training and SUS as predictors of workload, SUS is the only a significant predictor ($p = 0.041$).

Table 2. Observed System Outages during Go-Live and IOT&E Events

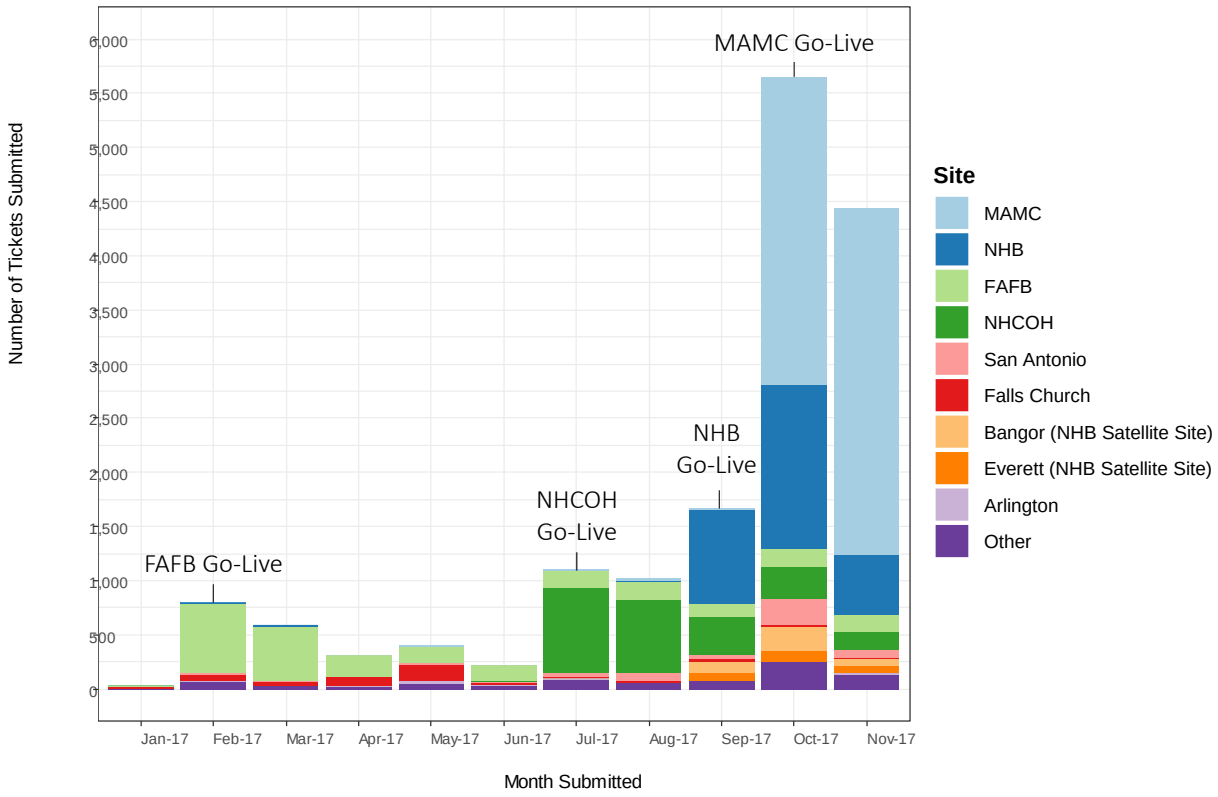
Event	Date	Description	Duration
FAFB and NHCOH IOT&E *(2 weeks)*	25 September	System outage attributed to NHB Go-Live	3 hours
	26 September	System outage (no further details)	2 hours
	2 October	Users unable to log in to the system	3 hours
	4 October	Users unable to log in to the system	6 hours
MAMC Go-Live *(1 week)*	29 October	Outage over the weekend (no further details)	3 hours
	7 November	Early morning outage (no further details)	8 hours
NHB IOT&E *(2 weeks)*	8 December	Users in the Urgent Care Clinic lost connectivity in five-minute intervals throughout the workday. Connectivity loss due to 1 of 2 routers being inoperable. IT personnel also needed to implement a software update and reconfigure the system.	~7 hours

IOT&E – Initial Operational Test and Evaluation; FAFB – Fairchild Air Force Base; NHCOH – Naval Health Clinic Oak Harbor; MAMC – Madigan Army Medical Center; NHB – Naval Hospital Bremerton

There were no data available to assess end-to-end reliability or availability. The PMO has begun to develop methods to collect current MHS GENESIS availability data at user devices, over the local and long haul networks, at Cerner data centers, and at interfacing systems to determine the end-to-end availability of the MHS GENESIS system-of-systems.

User Support

Users from the four IOC sites submitted 14,383 help desk tickets between January and November 2017. The number of help desk tickets became overwhelming for help desk personnel and for site personnel monitoring their status. Unless addressed soon, the help desk process will become unsupportable as the pace of MHS GENESIS deployments to new sites increases. As shown in Figure 4, the number of help desk tickets submitted increased with each Go-Live. As of December 19, 2017, the PMO closed 7,893 of the help desk tickets from the four IOC sites. At that time, 6,122 tickets remained open. The PMO designated 869 of them as "Requests for Change" that need approval by a board of senior user representatives from each of the Services prior to incorporation into the enterprise system. An additional 368 tickets from those sites were cancelled.



MAMC – Madigan Army Medical Center; NHB – Naval Hospital Bremerton; FAFB – Fairchild Air Force Base; NHCOH – Naval Health Clinic Oak Harbor

Figure 4. Help Desk Tickets by Month Submitted and Site

Scalability

Though scalability has not been formally tested, there are two indications that MHS GENESIS may not be scalable. First, users reported increased lag times during other site Go-Lives. Testers attributed one of the system outages during the IOT&E period at FAFB and NHCOH to the NHB Go-Live (Table 2).

Second, drop-down selection lists within the system include options from all MTFs because MHS GENESIS is configured as an enterprise system. For example, users need to search through the list of all printers installed at all MTFs to find the correct one when printers are not configured. Likewise, patients are able to schedule appointments with any provider in the enterprise system. The naming conventions on these lists are not standardized, making it difficult for users to find the option they are looking for. Without narrowing the lists or providing a standardized structure, these lists will become unmanageable as more sites use MHS GENESIS.

Survivability and Cybersecurity

JITC completed the first of three phases of a cybersecurity CVPA. The following are preliminary, unclassified findings based on the results of this first CVPA phase. JITC has

provided details of its findings to DOT&E and the PMO. DOT&E will provide full cybersecurity results in a classified report when cybersecurity testing is complete.

Preliminary Findings on Detection and Incident Response

Testing at the Cerner Technology Center exercised the incident response process, which includes both commercial defenders (LPDH and Cerner Cybersecurity Service Provider (CSSP)) and government defenders (SPAWAR CSSP). JITC worked closely with these defenders and the PMO to capture incident response following detection of the CVPA activities. Initial events identified delays in response times following detections. JITC attributed these delays to lags in email transmissions of up to 8 hours from the time a message was sent to the time received, when the two parties were across the hall from each other. Cerner Technology Center representatives reported that the email transmission lags were caused by security controls between government and contractor networks. Response times improved throughout the testing as Cerner Technology Center representatives made adjustments to the incident response procedures.

At the time of the testing, the SPAWAR CSSP did not have its monitoring and detection tools fully deployed in the production environment, which affected its ability to detect and respond to network events. These tools are critical to providing the SPAWAR CSSP with visibility into activities on the system.

Preliminary findings on Data Protection

The initial CVPA testing identified that the data stored within MHS GENESIS, including Personally Identifiable Information and Protected Health Information, is not protected in accordance with DOD standards. The SPAWAR Red Team demonstrated three pathways for users with low-level access to escalate privileges, thereby gaining more control over MHS GENESIS and the sensitive data stored within. The testing identified four other risk areas that the PMO should correct to improve the security of the system.

Recommendations

The Under Secretary of Defense for Acquisition and Sustainment should:

- Delay further fielding until JITC completes the IOT&E at MAMC and the PMO corrects any outstanding deficiencies.

The DHMSM PMO should continue to:

- Fix all Priority 1 and 2 IRs with particular attention given to those that users identified as potential patient safety concerns, and verify fixes through operational testing.
- Improve training and system documentation for both users and Adoption Coaches.
- Increase the number of Adoption Coaches and leave them on site until users are more comfortable with the new processes.
- Complete cybersecurity operational testing and continue to fix known deficiencies.

- Work with users to document, reduce, and standardize operational workarounds.
- Improve interoperability, focusing on interfaces identified as problematic during IOT&E.
- Monitor reliability and availability throughout the system lifecycle.
- Work with the Defense Health Agency and DISA to isolate network communications problems and reduce latency.
- Conduct operational testing at MAMC to evaluate untested functionality and corrective actions taken by the PMO.
- Conduct follow-on operational testing at the next fielding site to evaluate revised training and Go-Live process improvements.