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TITLE: Joint Medical Semi-Automated Forces (JmedSAF) to Joint Medical Workstation v2 (JMEWS2) Database

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1.0 General

JMedSAF provides medical facility, patient, patient treatment and patient evacuation simulation. The patient conditions (PC), treatment, and evacuation parameters are derived from the Deployable Medical Systems (DEPMEDS) data as defined by the Defense Medical Standardization Board. To support the Cobra Gold Command Post Exercises (CPX), additional patient conditions were created which represent milder forms of the DEPMEDS conditions and disease/non-battle injury distribution data was modified to provide a theater specific alternative distribution more in line with Master Scenario Event List (MSEL) objectives.

JMedSAF supported the CPX by simulating the planned medical facilities and their treatment of sick call and battle injury patients over a fifteen day period. In addition, specific injections of patients in support of medical MSEL events were conducted. JMedSAF output facility and patient reports to the Joint Medical Workstation (JMEWS) II system which provides a theater database for the Theater Medical Information Program (TMIP). The JMEWS II database provided database access to the MSE program which provided the common operating picture (COP) to the training audience, the CPX Coalition Joint Task Force (CJTF) surgeon and staff.

The Coalition Exercise Control Group (CECG) for Cobra Gold provided the CPX scenario environment via the Joint Tactical Logistics System (JTLS) simulation and response cell personnel. The CECG for CG06 was split between "in country" operations at Sattihip, Thailand, and Camp Smith, Hawaii. The Camp Smith component consisted of a JTLS database server and the medical cell systems (JMedSAF, JMEWS II, and MSE). Exercise communication was provided via a closed Coalition Wide Area Network (COWAN) established in Thailand with a reach back capability to Camp Smith.

The medical simulation cell configuration is shown in the figure below. Note that the configuration is simplified and represents the "local" Camp Smith COWAN only. The circuits, primary and backup, to Thailand are assumed in the diagram box labeled "Exercise COWAN".
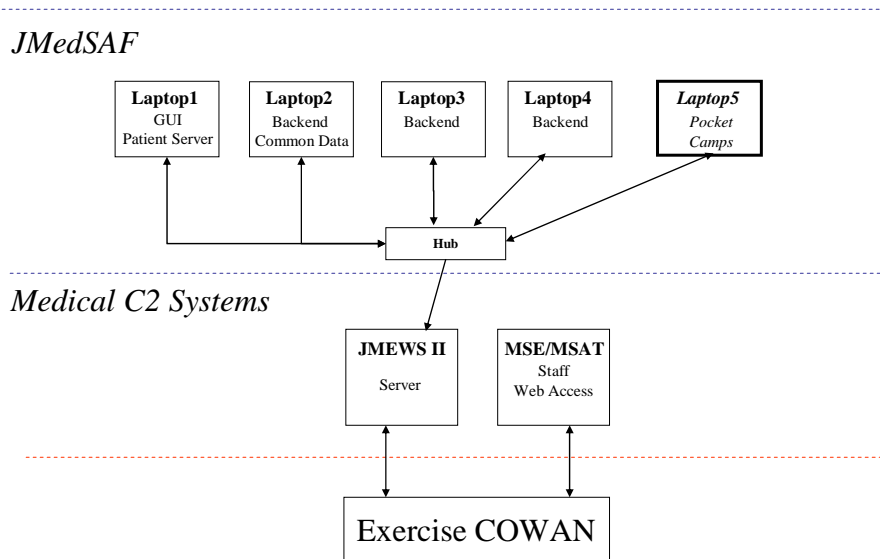

Cobra Gold 2006 Configuration Diagram

Figure 1- Simplified CG06 Configuration

2.0   Pre-Exercise Activity

2.1   Exercise Preparation

Exercise preparation consisted of three primary activities: data collection, scenario generation, and testing.

Data Collection:

There are three primary sources of information that provide the scenario entities and execution expectations. These are exercise planning documents (including OPORD and briefing materials), the Time-Phased Force and Deployment Data (TPFDD) and the Master Scenario Event List (MSEL).

The primary information needed is:
- Medical facility names, types, and locations
- Unit names and Population At Risk (PAR)
- Unit operating areas (which MTF will provide medical services)
- Exercise requirements for specific disease injections

The overall CPX story line and initial medical facility information was provided by Mr. Sashin and was based on planning conferences and his estimate of medical requirements.

The initial list of medical facility types was further enhanced by an MTF capabilities assessment from service representatives coordinated by Mr. Merrick Harrison (PACOM). This information was used to refine the facility templates used in JMedSAF.

Mr. Sashin also provided the initial set of medical related MSEL events. These were reviewed for JMedSAF support requirements or issues.

In place of TPFDD data, the tactical simulation JTLS database was used to extract unit identification, population, and location data. The JMedSAF team extracted this information during the Cobra Gold JTLS Database Test conducted 27 to 30 March 2006. During the JTLS database test period, MSAT coordination meetings were also conducted to establish scheduling and MSEL injections.

The March database test period provided the following information:
- Lists of JTLS unit names and locations were produced. (US, Thailand, and Singapore)
- A revised MSEL list.
- A revised medical laydown

Scenario Generation:

A JMedSAF scenario is represented by three sets of files: a single loadable scenario file consisting of MTF entities, a file defining the theater level sick call level and locations, and a set of clean facility "saved" files which defines modifications to staffing or other parameters for each facility.

Based on the data obtained during the MSAT coordination meetings, the core scenario file was constructed and, after modifications were made, the "saved" files were created. The creation of the theater sick call file required considerable additional effort.

The nature of JTLS required use of three different systems to produce a list of exercise units for each national participant. In addition, the Cobra Gold 2006 exercise was set in a fictional continent which was basically the United States west coast dropped into the middle of the Pacific Ocean. This fictional continent was named "Pacifica". JMedSAF does not have a terrain database for Pacifica and therefore used the actual United States west coast terrain. In order to create the master theater Disease Non-Battle Injury (DNBI) file, the JTLS position for each unit (a list of 813 culled from the original 1150) had to be translated and plotted on the US west terrain so that the appropriate sick call MTF could be identified.

The JTLS output does not include the actual manning level of these units but merely identifies them as organization entities (Division, Brigade, Battalion, etc.). In addition, the service (USA, USMC, RTA,

RTMC) is not included. The units are merely identified by country (US, Thailand, or Singapore). Population numbers for each unit were derived by assigning the normal level for that echelon. Service identification was derived by backtracking the listed "HQ" to the CARFOR, CMARFOR, or CAFFOR organizational structure.

In addition to the tactical scenario development, a separate scenario was created to simulate one of the CPX refugee camps. The scenario information was derived from the camp descriptions document. The same set of scenario and supporting files were created and additional disease trend files (DDJ) were created to represent the camp diseases prevalent outside the normal frequency distribution.

Testing:
During the March and April 2006 time frame, software changes were made to expand the JMEWS II interface and improve JMedSAF processing. As these changes were implemented, unit and system level testing was conducted.

As the scenario generation process came together, practical testing of the scenario was conducted. The objective of this testing was to verify MTF process of all patient types, patient flow within the medical laydown, and to identify any issues resulting from MTF locations and limitations. In addition, the disease and injury frequency distribution tables were tested and modified to provide a CG06 specific disease distribution. This alternate theater DNBI table was tailored to support a general increase in respiratory conditions and other MSEL related conditions.

From 11 to 13 April, an end-to-end test was conducted at the Fleet METOC Advanced Concepts Laboratory (FMACL), Coronado, CA. This test was to verify the JMedSAF to JMEWS II to MSE interface configuration. The design was to primarily test the data transfer rather than content. As the test progressed, some issues concerning JMedSAF input were uncovered and these were addressed either in JMEWS II parsing or in JMedSAF software changes. After the test was completed on 13 April 2006, a JMEWS II system was left at the FMACL and the JMedSAF team provided additional support to the MSE developers over the next two weeks.

2.2 Security Preparations

Connection to the exercise COWAN required approval from PACOM. Note that (see figure 1 above) JMedSAF did not physically connect to the COWAN, but was connected to the JMEWS II server which did have a COWAN connection. As part of the "medical systems" configuration, JMedSAF was required to complete network security documentation. Documentation consisted of the Security Profile Alteration Request (SPAR), a systems description, and results of the Security Readiness Review (SRR) of the Security Technical Implementation Guidelines (STIG).

Mr. Granger, Akimeka LLC, was tasked with creating the MSAT systems package. The SPAR and systems description was delivered to Mr. Granger 16 March 2006.

In preparation for the STIG review, all JMedSAF systems were rebuilt from scratch use the Fedora Core 3 Linux operating system. The systems were locked down within the limits of Linux and the required JMedSAF environment. After the rebuild and JMedSAF software installation, the STIG SSR was run on each of the five systems. Additional security modifications to the system were made in response to the SSR results and the SSR was repeated. The output for each system was reviewed and compiled into one SRR form for delivery to Mr. Granger. The SRR results were delivered 19 April 2006.

2.3 Documentation

The JMedSAF User Guide was updated to reflect the JMEWS II interface and other modifications made to date. The updated manual was delivered 7 April 2006.

3.0   Exercise Preload Period

Upon arrival on the afternoon of 8 May 2006, I proceeded to Camp Smith to set up for the exercise. The JMEWS II and MSE systems had been staged early in the morning and were ready for operations. After setting up the JMedSAF systems, the scenario was initialized and the connectivity between the three systems was tested. The exercise COWAN was not available at this time and therefore the connectivity to Thailand could not be tested. It was noted that the JMedSAF interface program, resident on the JMEWS II server, was not responding to multiple JMedSAF backend systems input. It appeared that the simultaneous input from the four systems was not being accepted and the JMedSAF systems were timing out the interface and discarding messages. This configuration had received only limited testing in the SPAWAR laboratory with no apparent errors. The laboratory configuration, however, was conducted with a JMEWS running on Windows XP standard PC and the Camp Smith system was a server computer running Window Server 2003. JMedSAF was reconfigured to run the facilities on a pocket system, which would limit output to one system. In addition, backend systems were initialized after loading the scenario to handle evacuation vehicles and troop entities needed for wounded in action (WIA) injections.

A preload of the facility and patient database was started on 9 May 2006. The preload period ran though through the 16th of May when the CPX officially started. This provided seven days of history for the CJTF surgeon to use at the start of the exercise.

During the preload period, it was discovered that JMedSAF would experience a segmentation fault when the every six hour set of MEDSITREP reports were generated with patients occupying an intensive care unit (ICU) bed. To provide the means to correct this problem and any future issues, one of the backend systems was taken off line and was reconfigured to allow recompilation capabilities. Mike Healy, in San Diego, provided the code change to correct the error and the software was recompiled and distributed to the exercise systems.

Additional issues with JMedSAF message output to JMEWS II were identified during the preload period. These were:

- JMedSAF maps patient treatment requirements against one set of doctor/nurse position titles with no service specific breakdown. JMedSAF output facility XML messages with the text of this list rather than occupation codes unique to each service. This caused JMEWS II to indicate erroneous staff levels for all non-US Army facilities. This issue was addressed in JMEWS II (Matt Rauls) by changing input parsing of JMedSAF messages to accept JMedSAF categories and provide more accurate staff levels.
- JMedSAF has "hard coded" the theater command as "PACOM". This caused some concern at the CJTF because the Thailand and Singapore medical facilities appeared to be commanded by PACOM. This issue was not addressed and the CJTF staff was made aware of the issues and basically ignored this display information.
- JMedSAF had preset supplies stock levels for a selected set of supplies. The MSE and JMEWS display of this information indicated a "red" (zero) status for these items as JMedSAF messages did not set the "on hand" value as well as the "stock level" value. This problem was fixed in JMedSAF by the start of the exercise (16 May 2006).

Mr. Mike Healy arrived on 15 May 2006 and immediately joined the team at Camp Smith. During the exercise, Mike investigated JMedSAF issues and errors as they were discovered and, if possible, provided corrected/improved software.

4.0   Exercise Period

The CPX started on 16 May 2006 and ran continuously until 23 May 2006 (Thailand dates were 17 May to 24 May 2006). Medical simulation cell staffing was provided for the "Thailand" day shift period only. The shift started at approximately 13:00 Hawaii time and ended at approximately 01:00 Hawaii time. The following is the general daily schedule (Hawaii times only):

Time(s)	Activity

Time(s)	Activity
13:00	Review system status, recalculate "bed counts" and modify MEDSITREPS, prep for morning synchronization phone conference.
14:00	Morning synchronization conference with in-country personnel, MSEL discussion, problem/issue discussion
13:00 – 23:59	Monitor patient activity and simulation performance, inject patients needed for MSEL support.
16:00 – 23:00	WIA patient identification and injection (Mr. Sashin called from Sattihip Thailand with the WIA numbers when they became available).
18:00	Provide Annex Q type data for input to CJTF (C. Riley forwarded via email to CDR Moszkowwicz).
00:01	Evening synchronization phone conference, MSEL discussion, problem issue discussion.

4.1   *Major Issues Affecting JMedSAF Operations*

JTLS Coordination

The JTLS tactical simulation had no direct connectivity to the medical simulation. The medical simulation cell at Camp Smith was to have access to a JTLS console for coordination purposes. This was to allow identifying and locating units for medical MSEL purposes and to allow report generation of wounded in action (WIA) activity. The PACOM staff supporting the Camp Smith component provided staff coverage during the Thailand night shift period only and a console was not initially available for medical cell use.

A JTLS console was finally provided but was of limited value. This was due to the inability to derive service/unit WIA report numbers from the JTLS interface. Information of some sort was available at the individual unit level, but WIA values were listed in "short tons" and I did not know how many people were in a short ton. In addition, connectivity problems between Hawaii and Thailand were overcome at the CECG by shifting operations to the "in-county" JTLS server. The local console provided was either out of synchronization with the in-country server running the game or plagued by the connectivity issues.

The JMedSAF WIA injections were dependent upon phone or email contact with Mr. Sashin at the CECG in Sattihip, Thailand.

JMedSAF Bed Count Underreporting

A known problem with JMedSAF processing is the current accounting of patients in a "waiting evacuation" status. The current processing does not allocate a "bed in use" for these patients and therefore a facility report of status will not show the appropriate bed count. While appropriate software modifications have been investigated and outlined to correct this issue, funding has not been allocated to effect these changes.

Under normal operations, JMedSAF automates the Medical Regulating function and automatically provides theater wide evacuation management based on patient condition needs and facilities capabilities. The automated regulating function will somewhat mitigate the underreporting problem by shortening the time period during which the bed counts are inaccurate by moving patients in a timely manner. If there are no mass casualty situations and sufficient evacuation assets available, the MEDSITREP (every six hour schedule for CG06) should contain data close to the expected bed count. The exception may be the medical facility closest to an out of theater staging facility where patients will be held until the out of theater transport is scheduled.

There were many MSEL events that required the CJTF Surgeon to investigate or take on the medical regulating function. To support these events, JMedSAF has to "shutdown" the automated regulating function. This is due to the fact that JMedSAF does not support "directed evacuation" for an individual patient such as "send patient A to facility X". Patient "A" will only go to facility "X" if the rules for the patient condition, facility staff, supplies, and distance come up with facility "X" as the right answer. To

prevent JMedSAF from automatically moving the patients of MSEL interest, all evacuations had to be suspended. This caused a considerable backlog of patients "waiting evacuation" at most of the facilities and a significant underreporting of bed usage.

To provide more accurate input to JMEWS II and thus better data available at MSE, the automated processing of JMedSAF MEDSITREP messages at JMEWS was turned off. This does not prevent these messages from going to JMEWS, but merely prevents them from updating the database. A corrected bed count for each facility with patients "waiting evacuation" was constructed and the latest MEDSITREP for these facilities in the JMEWS input directory was manually edited. After the editing was completed, non-essential messages were removed from the directory and the automated process was turned on to process the corrected MEDSITREP messages. After processing, the process was then stopped. This manual procedure was conducted prior to the "morning" phone call and once again before the daily summary data was sent to the CJTF.

4.2   JMedSAF Issues Affecting JMEWS/MSE

Multiple "People" Table Entries for Single Patient

The creation of a new patient by JMedSAF should result in one entry in the JMEWS "people" table. Subsequent JMedSAF message input for a patient would then be linked to the same "people" table record so that an historical list of events for a patient could be displayed. JMedSAF errors caused the JMEWS input processing to identify subsequent reports as "new" patients and create a new "people" table entry. The result was that a patient search of the database would show multiple entries for the same name and SSN and the user would have to piece the history together by reviewing each separate entry.

This problem was due to errors in the save and restore function at JMedSAF. JMedSAF writes periodic "save files" for each facility to disk so that, should a system failure occur, the facility patient load can be restored and "treatment" continued. It was discovered during the exercise that two pieces of data for patients that JMEWS uses to link patient records were not being saved in the files. The "admission time" and "date of birth" items are used as one of many "key" fields in JMEWS to identify patients. Since the data for these fields were not in the MTF save files, when a failure forced the reloading of these files subsequent reports for recovered patients did not have the correct data (zero for both fields – patients were 2004 to 2006 years old). The result was a "new" person being created in JMEWS.

In addition, it was discovered that the "admission time" information was not included in the JMedSAF evacuation messages (Trac2es format reports). This caused JMEWS to create "new" people for each Trac2es message received.

This error affected only inpatients who were recovered from a saved file and patients who were evacuated in or out of theater. Outpatients were not affected.

The "save file" errors was corrected in JMedSAF, however, implementation of the new software was delayed because change affected the reload process and would result in the loss of all current patients. The change was implemented on 22 May 2006 when it was deemed that the loss of inpatient status would no longer pose an exercise problem.

Injury Type and DNBI Category

JMedSAF was not setting the injury type field in patient messages. This resulted in the inability to identify and sum WIA patients at JMEWS/MSE. This was corrected on 19 May 2006.

JMedSAF attempted to output the DNBI category that was mapped to the DEPMEDS patient condition. The information was formatted by JMedSAF as a list code rather than text as specified in the JMEWS Interface Control Document for SAMS9 and CHCSIIT. Apparently JMedSAF was using the wrong

JMEWS DNBI code table ("dnbi_category" was used) and this resulted in the JMEWS display of erroneous category information. Fortunately, the MSE program performed its own DNBI mapping based on ICD9 information and the erroneous category data had limited distribution. It was determined that easiest solution was to modify JMedSAF to not submit category information. Since there was limited use of JMEWS displays at the CJTF, it was decided not to attempt a JMEWS manual correction of existing data. The JMedSAF change was implemented on 22 May 2006.

4.3 *JMedSAF Errors Addressed During the Exercise*

There were four major recompilations of the JMedSAF software to correct numerous issues discovered during the exercise period. Updated software was installed on 5/16/06, 5/19/06, 5/20/06, and 5/22/06. All installations occurred only on the tactical scenario systems. The system providing refugee camp simulation did not perform any "inpatient" processing and did not crash during the exercise. Therefore, the significant issues were not encountered on this system.

The following is a list of the JMedSAF errors identified during the exercise period. These errors could have been found with more pre-Ex integration testing.

1) Set the "on hand" to equal the "stock level" value in the MEDSITREP. (Corrected)
2) If a facility is echelon 1, set the number refrigerators to zero. (Corrected)
3) JMedSAF needs to add a new service, "contractor", to allow certain civilians to be admitted to a military MTF. Using service "other" works for now. (This problem is unresolved at this time.)
4) JMedSAF needs the correct "duty status" to be set for a contractor and identify what JMEWS wants for his service. (This problem is unresolved at this time.)
5) The "vmtf admit" task was broken in the patient object rewrite and needs to be re-implemented. (This problem is unresolved at this time.)
6) JMedSAF CHCS Note message was not setting the treating facility correctly. The correction was to set "computer name" to the MTF name. (Corrected)
7) Outpatients entering a level 3 MTF were sending a CHCS Admit followed by a CHCS Discharge. A SAMS9 Encounter needs to be sent instead. (Corrected)
8) The "forced evacuation" function caused a segmentation fault because "evac_all" was setting the pointer to the patient instead of the pointer to the queue item. (Corrected)
9) Date of Birth data wasn't being saved so when a patient was restored, it appeared that he was 2006 years old. (Corrected)
10) The design of the "forced evacuation" function doesn't evacuate from several queues. It should at least evacuate the patients in the "evac_waiting" queue. (Corrected)
11) The "dest_mtf_id" was erroneously taken out of the "MTF_Notice" interaction and needs to be put back. (Corrected)
12) Dropping artillery on a company led to patient objects getting lost due to network overload. Since each soldier doesn't know about the other ones this will be difficult to fix. For now don't drop artillery on companies, use platoons instead. (This problem is unresolved at this time.)
13) When "forced evacuation" is used, need to send CHCS Discharges for the evacuated patients. (Corrected)
14) Admission date wasn't being saved in the MTF save file. (Corrected)
15) Sometimes patients appear to be waiting for an empty ER. This may be a display only issue – more investigation is needed. (This problem is unresolved at this time.)
16) Make sure that all "vmtf_update_patient" calls happen before the patient is queued.
17) Save scenario saves the number of beds at the time of the save since this is parametric data. If you subsequently change the number of beds the original numbers will come back when a scenario load is done. This information should be kept in the "saved MTF" file as well. (This problem is unresolved at this time.)
18) The ZG1 field in SAMS9 report was nested too deep. (Corrected)
19) The ZG1.1 field needs to be added to SAMS9 reports. This specifies the injury type. (Corrected)
20) The injury type also needs to be added to the CHCS Note message. (Corrected)

21) The "vmtf_admit_request" process needs to set the "battleInjury" parameter to FALSE if "autoevac" is true so that patients from the DNBI generator don't get battle injuries. (Corrected)

22) Some JMedSAF messages were not being parsed by the JMEWS FMS2 process and were sent to the "unprocessed" directory. This was due to the use of disallowed characters in the JMedSAF XML output. The characters ">" or "<" in the PC descriptions files were changed to "&GT:" and "&LT:". (Corrected)

23) When reading in "pcSubjective" the process was using VMTF_MAX_PCS instead of VMTF_MAX_PC_LENGTH. (Corrected)

24) The restore code needs to handle blanks in the nationality. This was causing segmentation faults during attempted restarts. (Corrected)

25) If a supply or staff value is zero, don't send it to JMEWS. (Corrected for supplies only.)

26) Don't send the DNBI category (ZG1.2) to JMEWS. (Corrected)

27) Reissue pickup requests doubles the number awaiting out of theater evacuation patients on the status display. (Corrected)

28) Add VMTF_STATE to "cancel_all_requested_pickups" parameters - vmtf_destroy, pass a NULL for this parameter. (Corrected)

29) Occasionally, null pointers are getting onto the queues. When this happens, the system will crash with a segmentation fault. (This problem is unresolved at this time.)

5.0   Post Exercise Activity

At the conclusion of the CPX, the systems were required to be scrubbed for security reasons. Prior to the disk wipe process, information needed to reconstruct events and activity was identified and manually recorded. The disk wipe was then started and was completed by the following day.

An After Action Review (AAR) for the medical cell had been scheduled for the afternoon of 25 May 2006. Due to scheduling conflicts for some of the participants, the AAR was postponed until a later date.

6.0   JMedSAF Performance Evaluation

JMedSAF errors/issues can be grouped into two categories: system stability and quality of data output to JMEWS II.

System Stability:
While the camp simulation system ran basically error free throughout the entire exercise, the tactical simulation experienced a number of failures. The basic difference is that the camp system processed outpatients only. No bed queuing, staff queuing, evacuations, WIA injections, or MSEL injections were done on the camp simulation system. All of these processing areas produced problems in the tactical forces simulation systems.

Data Quality:
As noted in section 3.0 above, there were several issues with JMedSAF message data content uncovered during the exercise. The most significant of these was the loss of "key field" data upon file recovery which caused JMEWS II to create erroneous "new" people rather than linking subsequent reports to existing patients.

The majority of other content issues were due to the lack of service unique identifiers. An example of misunderstanding of JMEWS II database parsing was discussed above in the DNBI category section. While documentation was available that indicated a code number was required, there was no indication of what the valid codes were.

There was no formal documentation available for the facility messages (MEDSITREP) as this is normally manually generated by an operator on the TMIP web service. The JMEWS II team provided a "Scenario Generation" package which provided automated parsing of JMedSAF facility messages. Some example XML was provided for the development effort, but there was little in the way of guidelines and this lead to some issues with JMedSAF MEDSITREP messages. For example, the simulation uses a generic staff list to map diagnosis to required treating personnel. In previous software releases, the generic staff requirement was mapped to a table of service specific occupation codes and only the code was passed to the medical database. This function was removed from the software because the MEDSITREP examples available during development listed only plain language occupation titles in the XML and therefore the generic list was used instead. This proved problematic because the only facilities showing staff levels were US Army facilities, as they were closest to the generic list categories. Leaving aside the Thailand and Singapore facility concerns, it is possible that if the occupation code output had been retained, JMedSAF output would have been of better quality.

Without a more detailed knowledge of the JMEWS II message parsing and database update process, the JMedSAF team could not make an informed decision regarding best practice. For example, JMedSAF output numbers for each staff position and supply category even if the appropriate number was a zero. During the exercise preload period, it was noted that MSE theater summary displays often indicated a red status due to the zeros in the JMedSAF input. Apparently, JMedSAF should not have included sections in the XML for those items that were legitimately zero. While there were no errors or issues with JMEWS II processing of the data, there was an impact on MSE display of the data.

7.0   Conclusions

All of the system and interface problems noted in this report should have been identified and corrected prior to the exercise. The fact that they were not is due primarily to the lack of adequate integration testing.

Prior to the exercise, the only time that all systems and support personnel were even in the same room was at the end-to-end test in mid April. The end-to-end test objective and short time frame did not lend itself to uncovering anything other than gross problems. Prior to the end-to-end test, development collaboration and testing was done via email or phone conversations. The JMedSAF reliance on format documentation without practical JMEWS II database experience or a readily available subject matter expert (SME) produced some "best guess" choices and limited the development review of data quality. A complete run through, before the exercise, with the full equipment suite and with all concerned personnel in one location would have greatly improved performance and data quality.