Prehospital Medical Documentation in the Joint Theater Trauma Registry: A Retrospective Study

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Background: Prehospital care of combat casualties is a critical phase of emergency medical practice on the battlefield. The Joint Theater Trauma Registry (JTTR) was developed to standardize a system of data collection for combat casualty care; however, the degree of population and granularity of prehospital data were unknown.

Methods: This is a retrospective comparative study of all US military personnel who sustained battle injuries in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). The JTTR was queried for all US military battle casualties from OIF and OEF entered between January 2002 and July 2009 containing any data entered into the prefacility fields. Data were separated based on origination, OIF, or OEF. A comparative analysis was performed.

Results: During the period studied, 13,080 (66%) entries into the JTTR were recorded in the category of "Battle Injury" and met study inclusion criteria; 3,187 (24%) battle injury entries contained prehospital data (n = 3,187). The percentage of casualty records containing prehospital data were 18.6% for OEF and 25.4% for OIF ($p < 0.01$).

Conclusion: Both poor population of data points and poor granularity of prehospital data entered into the JTTR were observed. It appears that the volume and quality of reporting of role-I data were better for OIF than OEF for this study period. Further investigations into the obstacles to free flow of role-I casualty clinical data, and the means to mitigate this situation, are warranted.

Key Words: War, Combat, Trauma, Registries, US military.

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Current coalition combat operations in Iraq and Afghanistan have served to highlight innovations in US military medicine and combat casualty care, and have also accentuated areas in need of improvement.[1] Out-of-hospital treatment of combat casualties is a critical component of emergency medical practice on the battlefield. Accurate understanding of battle injury (BI) is essential to improving tactical combat casualty care (TCCC).[2,3] Earlier articles by several authors have stated the importance of collecting casualty statistics for research programs to improve healthcare delivery and training of combat medics.[4,5] However, prehospital medical documentation of US military combat battle injuries is still deficient. In his study, Blackbourne[6] concluded, "There is currently no pre-hospital data for the combat wounded and a system for accurate documentation of pre-hospital care must be found."

Battle casualty clinical data are analogous to both patient care reports and hospital medical records that are routinely collected in out-of-hospital and inpatient phases of civil sector medical care, respectively.[7] There are several phases of care from which such BI information is gathered, from the point of injury in combat, to the battalion aid stations and combat support hospitals in theater, to the treatment received at the medical treatment facilities located in the United States. These correspond to "Roles" of care as defined by the North Atlantic Treaty Organization.[8] "Role I" medical treatment encompasses out-of-hospital and presurgical care analogous to "Level I" and "Level II" absent forward surgical attachments. "Role II" also encompasses out-of-hospital care but incorporates forward resuscitative surgical capability and advanced resuscitative techniques, thus requiring the presence of a Forward Surgical Team. "Role III" represents theater hospitalization, correlating directly to "Level III." Finally, in the North Atlantic Treaty Organization system, "Levels IV and V" are combined into "Role IV," representing continued surgical, recuperative, and rehabilitative care outside of the combat zone.

The Joint Theater Trauma Registry (JTTR) was established in 2004 and is a retrospective, standardized system of data collection, designed to encompass all the aforementioned roles of combat casualty care.[9] Population of the JTTR is dependent on the initial entry of casualty data into each individual medical record. By providing data to answer operational questions, the goal of establishing the JTTR was to improve coordination of care, better predict needed manpower, and answer medical questions such as injury patterns.[7] Several articles were reviewed for this study, and it was

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evident that the limitation experienced by the authors in many of the articles, both military and civilian, was the lack of data from point of injury and en route care, taken together encompassing the "out-of-hospital" phase of combat casualty care.[10–17]

The purpose of this study was to critically examine the out-of-hospital segment of the existing JTTR database, seeking to elucidate the degree of population (percentage of casualties with records) and granularity (percentage of completion of each record) of available data resulting from current role-I casualty care documentation practices. A secondary objective was to compare the amount and type of prehospital medical documentation among US battle casualties from Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF).

MATERIALS AND METHODS

This study was conducted under a protocol reviewed and approved by the US Army Medical Research and Materiel Command Institutional Review Board and in accordance with the approved protocol. We conducted a retrospective comparative study of all US military members who sustained BI in OIF and OEF that were entered into the JTTR between 03 January 2002 (the earliest recorded data) and 10 July 2009 (the start date for the query). The JTTR was queried for all US military battle injured from OIF and OEF containing any data entered into the prefacility data fields (Appendix A, Supplemental Digital Content 1, http://links.lww.com/TA/A61) during the period studied.

A statistician was consulted throughout this study. BI data were separated into two categories of origination: OIF and OEF. The primary outcome measures were percentage of patient records containing any out-of-hospital data (population) and for those containing such data, what percentage of fields contained data (granularity). These comparative percentages were analyzed via standard contingency table methods using the chi-square test. Prefacility data fields were given only dichotomous values (yes, no) to analyze whether data existed. In this study, the independent variable is operation (OEF, OIF). The dependent variable is prehospital documentation (yes, no).

Inclusion criteria for this study were US military with BI occurring in Iraq or Afghanistan during OIF and OEF, whose data were entered into JTTR from 03 January 2002 to 10 July 2009. The records of non-US military, civilian, contractor, detainee, combatant, those describing disease or non-BI, entries occurring in locations other than Iraq and Afghanistan, and any data that were entered into the JTTR after 10 July 2009 were excluded from this study.

Percentages of documentation for each prefacility data field were then calculated and comparison analysis was done between available data from OIF and OEF using the chi-square test. Sixteen of the JTTR's 27 prefacility data fields were examined and compared (Table 1). Two sets of data fields were combined: systolic blood pressure was combined with diastolic blood pressure, annotated as blood pressure. Eight data fields were recognized before data analysis as already known variable and therefore left out of calculations. They include injury date and injury month (all were in the inclusion criteria date range), patient category (all were US military), military operation (either OEF or OIF), injury class (all were considered BI), location (all were considered prehospital), medical treatment facility (all were transferred from prehospital care), and assessment type (all were prehospital assessments). Tourniquet time and procedure type were included in prehospital procedure. The 16 data fields evaluated were assessment time, heart rate, pulse, unassisted respirations, blood pressure, oxygen saturation, Glascow Coma Scale, Revised Trauma Score, pain scale, temperature, paralyzed, sedated, intubated, assisted respirations, medication description, and prehospital procedure (Appendix B, Supplemental Digital Content 1, http://links.lww.com/TA/A61). Prehospital medications and prehospital procedures recorded under each respective category were listed separately (Appendices B and C, Supplemental Digital Content 2, http://links.lww.com/TA/A62, and Supplemental Digital Content 3, http://links.lww.com/TA/A63).

TABLE 1. The Distribution and the Chi-Square Test for the Differences in Proportions for Each Prefacility Variable Between OEF and OIF

Variable	Total %	OEF %	OIF %	*p*
Assessment time	1,560 (48.9)	238 (66.5)	1,322 (46.7)	**<0.01**
Heart rate	2,590 (81.3)	319 (89.1)	2,271 (80.3)	**<0.01**
Pulse	459 (14.4)	52 (14.5)	407 (14.4)	0.944
Unassisted respirations	1,552 (48.7)	166 (46.4)	1,386 (49.0)	0.349
Blood pressure	2,319 (72.8)	283 (79.1)	2,036 (72.0)	**<0.01**
Oxygen saturation	1,438 (45.1)	115 (32.1)	1,323 (46.8)	**<0.01**
Glascow Coma Scale	1,489 (46.7)	162 (45.3)	1,327 (46.9)	0.554
Revised Trauma Score	1,776 (55.7)	250 (69.8)	1,526 (53.9)	**<0.01**
Pain Scale	156 (4.9)	6 (1.7)	150 (5.3)	**<0.01**
Temperature	506 (15.9)	60 (16.8)	446 (15.8)	0.628
Paralyzed	2,465 (77.3)	249 (69.6)	2,216 (78.3)	**<0.01**
Sedated	2,442 (76.6)	251 (70.1)	2,191 (77.4)	**<0.01**
Intubated	2,488 (78.1)	250 (69.8)	2,238 (79.1)	**<0.01**
Assisted respirations	3,055 (95.9)	357 (99.7)	2,698 (95.4)	**<0.01**
Medication description*	1,582 (49.6)	131 (36.6)	1,451 (51.3)	**<0.01**
Prehospital procedure†	1,216 (38.2)	88 (24.6)	1,128 (39.9)	**<0.01**
Total	3187	358 (18.6)	2,829 (25.4)	<0.01

* Appendix B: Medication listed in the JTTR.
† Appendix C: Prehospital procedure listed in the JTTR.

The top five data field entries were calculated. The average number of prehospital fields and the total number of prehospital cases entered into the JTTR were calculated and compared by year. Using the total number of BI and total number of prehospital cases entered into the JTTR, the percentage of prehospital BI cases entered into the JTTR was calculated and compared by year.

RESULTS

During the period studied, 19,944 records were identified in the JTTR. There were a total of 13,080 (66%) entries that met our inclusion criteria (recorded in the category of "BI," and US military personnel, within our study period). Of these, 3,187 contained some form of prehospital data within their medical record, yielding a prehospital data population of

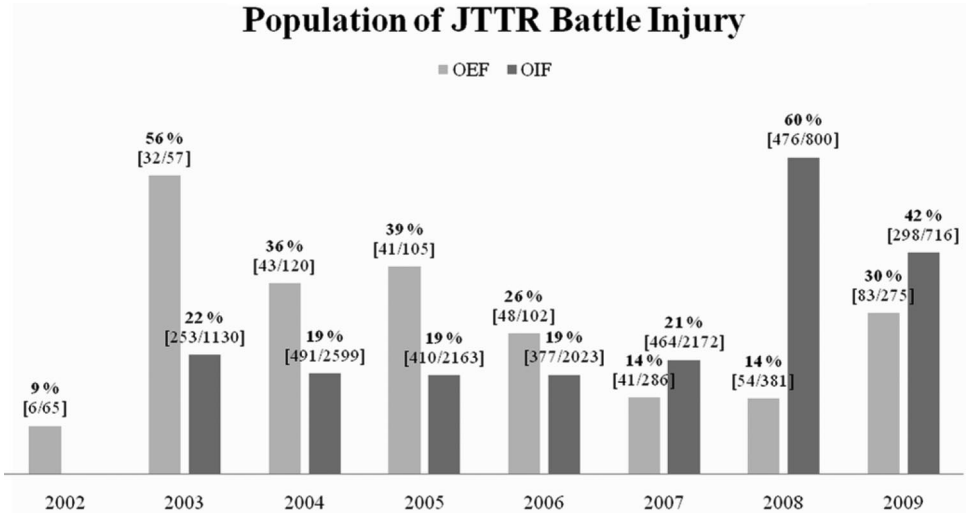

Figure 1. Population represented by the percentage of BI medical records containing prehospital data entered into the JTTR by year.

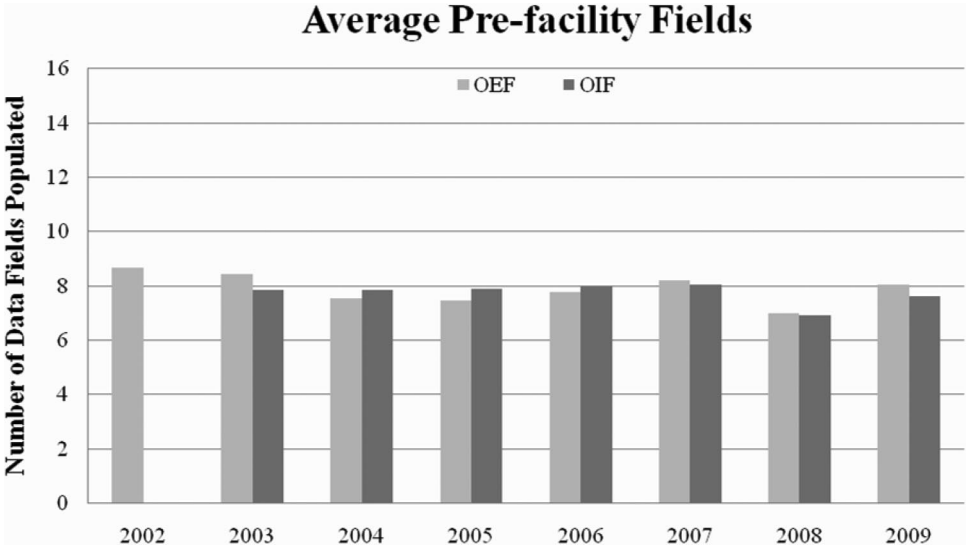

Figure 2. Granularity represented as the average number of prefacility fields populated with prehospital data entry by year.

24%. This percentage of prehospital data population between OEF (18.6%) and OIF (25.4%) was significantly different, at 6.8% ($p < 0.01$) (Fig. 1).

Granularity is represented on Figure 2 which shows the average number of prefacility fields populated with prehospital data entry by year. Of the 16 data fields analyzed, there were only a few years that averaged more than eight data fields. Figure 3 shows the granularity of each prefacility data field populated by the individual percentages that were entered into the JTTR.

The percentage of medical records with the number of prefacility data fields populated is shown in Figure 4. Table 1 shows the 16 variables we analyzed of the 27 variables available. The 11 variables that were not analyzed were excluded because they were part of the inclusion criteria (i.e., injury date, all data were within the inclusion criteria date range). There was a statistically significant difference in the proportions of 12 of the 16 variables between OEF and OIF ($p < 0.01$). Of the 3,000 plus medical records with existing prehospital documentation, the top five prefacility data fields populated were assisted respirations, heart rate, intubated, paralyzed, and sedated.

DISCUSSION

This is the first study to examine the out-of-hospital segment of the existing JTTR database to elucidate the degree of population (percentage of patient medical records containing any out-of-hospital data) and granularity (percentage of prefacility data fields containing data) of available data resulting from current role-I casualty care documentation practices. Rather than scrutinize each data point that occupied a

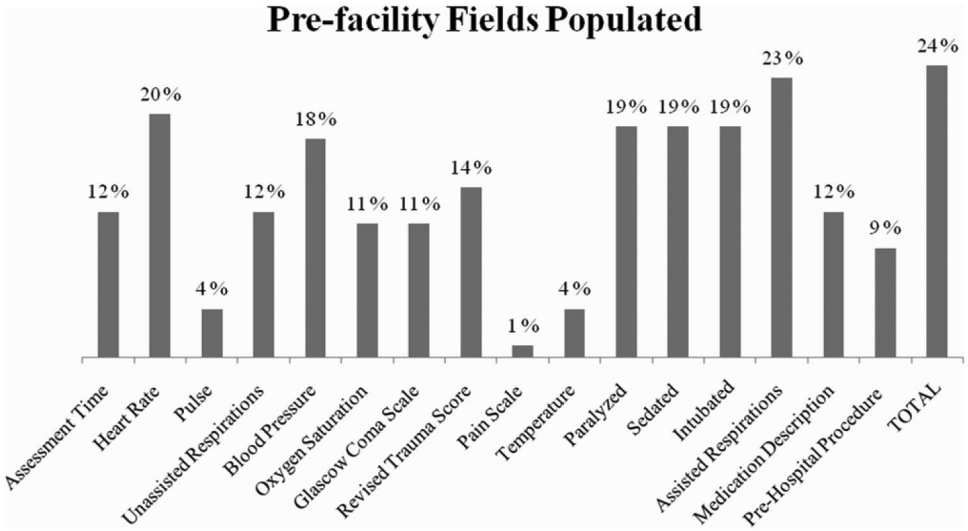

Figure 3. Granularity of prefacility data fields populated as percentage of total battle injuries entered into the JTTR.

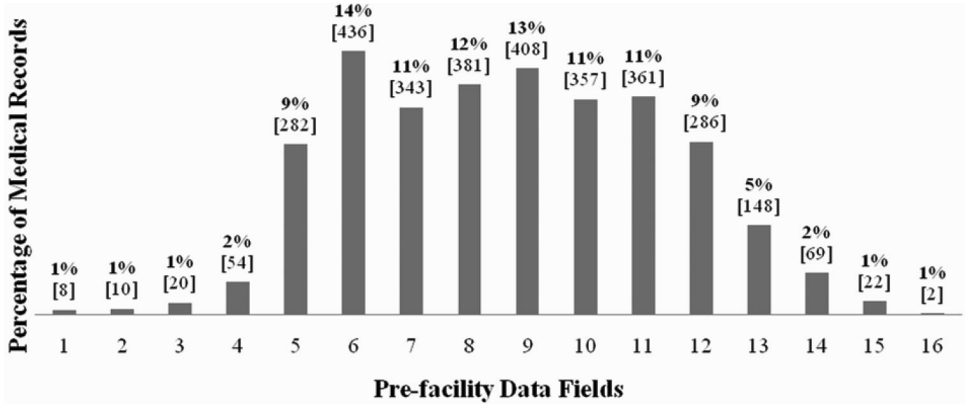

Figure 4. Medical records with the percentage and total number of medical records of prefacility data fields populated.

particular data field, we instead focused on whether or not a data point existed in each particular data field. In a 2007 unpublished letter to the Committee on TCCC, Jenkins reported that less than 10% of casualty medical records had any prehospital documentation and that only 1% of cases available had sufficient information (Colonel [Retired] Don Jenkins, unpublished data). In this study, it was calculated that 24% of all US combat casualties, from all branches of service, had various amounts of prehospital documentation in the medical records. Furthermore, a 6.8% difference was statistically significant ($p < 0.01$) when comparing data collected between OEF (18.6%) and OIF (25.4%). Although these results yielded a slightly higher percentage than the Jenkins report, we agree that the population captured from role-I casualty care documentation remains inadequate.

Although ascertaining that only 24% of current JTTR battle injured servicemen had prehospital documentation in their medical records, the determination of a possible yearly trend in the percentage of documentation was evaluated. With these conflicts now entering their eighth year, it was speculated that collection of prehospital medical documentation would be improving, thus facilitating a positive trend and enhancement in the data collection system. Figure 1 demonstrates that the degree of data entry for the population in both OEF and OIF remains deficient with no discernable trend. OEF's 56% data collection in 2003 may be attributed to the few number of casualties entered into the JTTR for that year. It was noted that percentages in subsequent years decreased while the number of battle casualties increased. OIF's 60% data collection in 2008 may correlate to numerous events. One event, the increasing levels of troops in Iraq during the "surge" that began in 2007 and continued through most of 2008, may have resulted in a change in the battle casualty rate. Also occurring in mid-2007, Brigade Combat Teams located throughout Iraq, which are included as role-I, were fielded with the Medical Communications for Combat Casualty Care (MC4) computer system for documentation of casualties. Incorporation of this computer tracking system may also account for the spike in improved prehospital documentation in 2008.

With the contention that the current prehospital data being collected is insufficient, or lacking medically signifi-

cant information, the granularity of each prefacility data field populated was examined (Table 1). Twelve of the 16 data fields had a statistically significant difference in percentage ($p < 0.01$) between OIF and OEF. This finding strengthens our assertion that the data collected are indeed too scarce to be of practical value. Of the 3,187 medical records with existing prehospital documentation, the top five prefacility data fields populated were assisted respirations, 95%; heart rate, 81%; intubated, 78%; paralyzed, 77%; and sedated, 76%. These top five data fields may represent critical information that prehospital providers wanted to ensure would transfer to the higher level of care, perhaps providing a better continuity of patient care and prognostic indicators. It may otherwise suggest clinical information the receiving facility deemed important, thus facilitating documentation of this data into the medical record.

The granularity of each medical record was an important aspect of this study, as such it was analyzed from several different perspectives. First, the average number of prehospital fields entered into the JTTR was compared by year and origination (Fig. 2). This analysis revealed poor granularity of each medical record existing for OIF, with only 2007 averaging at least eight data fields. OEF had 4 years with slightly greater than 8 of the 16 data fields populated per medical record. Figure 3 represents the percentage of granularity for each particular prefacility data field studied of the 13,080 medical records in the JTTR containing BI data. Perhaps the greatest evidence of the lack of prefacility data population (granularity) is shown in Figure 4. This graph represents the number and percentage of data population of the 3,187 total medical records that contain prehospital data.

The majority of the medications listed in the prefacility fields of the JTTR, with the exception of Morphine, are primarily initiated at Level Ib or IIa by licensed medical providers with prescriptive authority (Appendix A, Supplemental Digital Content 1, http://links.lww.com/TA/A61). The list of prehospital procedures include central lines, cardiopulmonary resuscitation, emergency department thoracotomy, and tube thoracostomy, which again are primarily initiated by licensed medical providers at Level Ib or IIb. The medication list and the prehospital procedure list led to the speculation that the majority of the prehospital documentation occurred at Level Ib or IIa, not at the point of injury.

In the future, the ability to conduct evidence-based analysis of the medical devices and techniques used at the point of injury hinges on our documentation of the effects of those techniques and devices and the accurate description of the patients they were used on which they were used. This study clearly shows that the US military is deficient in role-I medical documentation. One method currently under study to improve this short fall is the method of documentation developed by the 75th Ranger Regiment, located at Fort Benning, GA.

In the most recent update on TCCC, the 75th Ranger Regiment is cited as possessing the most successful prehospital documentation program.[18] The Regiment has developed a twofold process for collection of Level 1 data. The first portion is the TCCC card, which is completed for each patient (Appendix D, Supplemental Digital Content 4, http://links.lww.com/TA/A64). This card is easy to read, understand, and can be filled out by both medical and nonmedical personnel. The second portion is the medical after action review. After each casualty event, when the medic returns to base, he is required to enter the data into an internal database developed by the Regiment. These data were consolidated at the Regiment level for analysis.[19] Although this system has worked well within the community for which it was designed, it is unknown whether such a method will translate effectively to the conventional force with its decentralized and unit-of-action-based medical oversight, disparate levels of documentation enforcement, and multiple sources for data input. The Army implemented the TCCC casualty card in mid-2009 in expectation of improving the point of injury data collection system. Since that time, the effectiveness of this implementation has yet to be explored.

Further steps to ensure that documentation occurs can be implemented, such as command emphasis on prehospital medical documentation and enforcement that all medical and nonmedical personnel actually use the TCCC card on all combat casualties. Furthermore, the TCCC card should be considered an official medical document, and therefore become a part of the casualty's permanent medical record. By doing so, this will facilitate accountability of the TCCC card because it accompanies the casualty throughout each echelon of medical care.

The idea of a hands-free voice recording device for use by all medics to augment real-time recording of casualty treatment on the battlefield is currently in development. This device, roughly the size of a standard computer memory stick, is attached to the medic's uniform. It will enable the medic to verbalize the mechanism of injury, initial physical examination, injuries, initial treatment, and medications administered to the casualty. Once the medic reaches a medical treatment facility, this device can be attached to a standard computer docking system where the information is uploaded and used by medical providers to improve continuity of care. The information may later be transcribed by a medical transcriptionist and placed into the casualty's permanent medical record and, subsequently, the JTTR. This device should be implemented once it becomes available.

The information gathered in this study is invaluable to the US military. The ability to use out-of-hospital data, statistics, and trends to improve command visibility of casualties and augment real-time decision-making process on the battle field is the ultimate goal of prehospital data collection in the combat environment. Further investigations into the obstacles to free flow of role-I casualty clinical data, and the means to mitigate this situation, are warranted. Future studies may also revisit the topic of available prehospital data in the JTTR to investigate whether or not the implementation of the TCCC card actually improved the out-of-hospital data collection process. This study should be used as the initial platform to refine combat casualty evacuation, enhance personnel, training, and equipment and improve the collection process of combat casualty out-of-hospital medical documentation.

Several limitations exist in this study, the most important is the apparent backlog of medical records not entered into the JTTR during the period studied. JTTR prehospital data points currently depend on hard copy or verbal recall receipt of data from evacuation crews on arrival at the emergency medical treatment sections of theater hospitals. Although identifying the absence of prehospital data for the majority of casualties was possible, specific causes for this are unknown but may include the following: recall bias, lack of data recording, loss of data, multiple transfers and providers in the complex evacuation chain, and logistical difficulties associated with abstracting these data into the JTTR record at the theater hospital sites.

Prehospital documentation remains essential to the continuum of care for the combat casualties. We observed both poor population of data points and poor granularity in the volume of prehospital data entered into the JTTR, most likely resulting from obstacles in recording and forwarding of role-I TCCC documentation. It is likely that sparse documentation enforcement, inconsistent medical oversight, and receiving facility perception with regard to value of prehospital data also contributed to this situation. As shown by the data presented, the volume and quality of reporting of role-I data were better for OIF than OEF for this study period.

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