Standardizing Military Medical Training Data without Changing the Execution of Training

Amanda E. van Lamsweerde, Erin Baker
Naval Air Warfare Center Training Systems Division
Orlando, Florida
amanda.e.vanlansweerde.civ@us.navy.mil,
erin.a.baker2.civ@us.navy.mil

Jeffrey M. Beaubien
Aptima, Inc.
Woburn, Massachusetts
jbeaubien@aptima.com

Ruben Garza, Brett Lord
Defense Health Agency
ruben.garza44.civ@mail.mil
brett.k.lord.civ@army.mil

Cali Fidopiastis
Katmai Corporation
Orlando, Florida

cfidopiastis@katmaicorp.com

Michael Guest, Sandra Hughes
Naval Air Warfare Center Training Systems Division
Orlando, Florida
michael.a.guest7.civ@us.navy.mil, sandra.c.hughes4.civ@us.navy.mil

ABSTRACT

The Military Health System (MHS) currently faces a number of infrastructure challenges pertaining to learning and performance improvement. Currently, the MHS processes and systems in place cannot report enterprise-wide education, training, and human performance metrics. For example, across the Services and Defense Health Agency (DHA), multiple training and education systems collect and store data using different methods, resulting in a multitude of formats. These isolated systems do not have sufficient connectivity and interoperability to exchange data and information or produce integrated analytics that represent the systems as a whole. This lack of MHS training data infrastructure results in a subpar ability to report enterprise-wide education, training, and human performance metrics. To address this issue, the Interoperability Networking for Training, Readiness, and Education in Medicine (INTREMED) effort will address these issues by centralizing training data across these systems. Once centralized, the goal is to create an enterprise-wide strategy that allows for data to be collected in a standardized manner across the Services while allowing each Service the freedom to control how training is administered and conducted. The purpose of this project was to develop a framework for standardizing this data. Personnel across military medical Service occupations were interviewed to understand what data are used to evaluate performance and where that data are stored. Results revealed that medical occupation training data fit largely into sixteen major categories, utilized across Services and roles. The use of a particular categories are driven more by role-based requirements than Service-based requirements; this framework will therefore provide a particularly useful means of analyzing data across services. These categories can therefore be used to standardize existing data so that performance can be evaluated across services without requiring a change to training.

ABOUT THE AUTHORS

Amanda E. van Lamsweerde is a Research Psychologist for the Naval Air Warfare Center Training Systems Division. Dr. van Lamsweerde holds a PhD in Cognitive Psychology with a focus on learning and memory.

Erin Baker is a Research Psychologist for the Naval Air Warfare Center Training Systems Division with over a decade of training and education experience. As the technical lead for the INTREMED program on behalf of the Defense Health Agency, Mrs. Baker informs the vision for the future centralization and standardization of training and education data across the Military Health System. Ms. Baker holds an M.S. Industrial/Organizational Psychology and a B.S. in Psychology from the University of Central Florida.

Jeffrey M. Beaubien is the Chief Behavioral Scientist at Aptima, Inc. For the past 20 years, his work has focused on training and assessing leadership, teamwork, and decision-making skills. Dr. Beaubien holds a Ph.D. in Industrial and Organizational Psychology from George Mason University, a M.A. in Industrial and Organizational Psychology from the University of New Haven, and a B.A. in Psychology from the University of Rhode Island.

Ruben Garza has over 12 years of experience in medical modeling and simulation and currently serves as the chief of the Defense Medical Modeling and Simulation Organization. Mr. Garza holds a Master's in Business Administration from Wayland University.

Brett Lord is an Assistant Program Manager with DHA's Program Manager for Medical Simulation and Training (PM MST) office. Mr. Lord has led a variety of simulation programs, including virtual, constructive, and medical simulations, throughout his military and civilian career. Mr. Lord holds an M.B.A. and M.S. in Management from the Florida Institute of Technology, a M.S. in Biochemistry from Louisiana State University, and a B.S. in Biology from the University of South Dakota.

Cali Fidopiastis is a Chief Scientist with 15 years' experience in the design and development of military training systems. As Technical Lead for Katmai Corp, she provides expertise for the research and development of INTREMED's conceptual and logical design, as well data management strategies.

Sandra Hughes is a Research Psychologist for the Naval Air Warfare Center Training Systems Division with an M.S. in Industrial/Organizational Psychology. Her work has focused on team training and decision-making, as well as organizational development.

Michael Guest is a Senior Research Psychologist for the Naval Air Warfare Center Training Systems Division.

Standardizing Military Medical Training Data without Changing the Execution of Training

Amanda E. van Lamsweerde, Erin Baker
Naval Air Warfare Center Training Systems Division
Orlando, Florida
amanda.e.vanlansweerde.civ@us.navy.mil,
erin.a.baker2.civ@us.navy.mil

Jeffrey M. Beaubien
Aptima, Inc.
Woburn, Massachusetts
jbeaubien@aptima.com

Ruben Garza, Brett Lord
Defense Health Agency

Cali Fidopiastis
Katmai Corporation
Orlando, Florida
cfidopiastis@katmaicorp.com

Michael Guest, Sandra Hughes
Naval Air Warfare Center Training Systems Division
Orlando, Florida
michael.a.guest7.civ@us.navy.mil, sandra.c.hughes4.civ@us.navy.mil

Amanda E. van Lamsweerde is a Research Psychologist for the Naval Air Warfare Center Training Systems Division. Dr. van Lamsweerde holds a PhD in Cognitive Psychology with a focus on learning and memory.

Erin Baker is a Research Psychologist for the Naval Air Warfare Center Training Systems Division with over a decade of training and education experience. As the technical lead for the INTREMED program on behalf of the Defense Health Agency, Mrs. Baker informs the vision for the future centralization and standardization of training and education data across the Military Health System.

Jeffrey M. Beaubien is the Chief Behavioral Scientist at Aptima, Inc. For the past 20 years, his work has focused on training and assessing leadership, teamwork, and decision-making skills. Dr. Beaubien holds a Ph.D. in Industrial and Organizational Psychology from George Mason University, a M.A. in Industrial and Organizational Psychology from the University of New Haven, and a B.A. in Psychology from the University of Rhode Island.

Ruben Garza has over 12 years of experience in medical modeling and simulation and currently serves as the chief of the Defense Medical Modeling and Simulation Organization. Mr. Garza holds a Master's in Business Administration from Wayland University.

Brett Lord is an Assistant Program Manager with DHA's Program Manager for Medical Simulation and Training (PM MST) office. Mr. Lord has led a variety of simulation programs, including virtual, constructive, and medical simulations, throughout his military and civilian career. Mr. Lord holds an M.B.A. and M.S. in Management from the Florida Institute of Technology, a M.S. in Biochemistry from Louisiana State University, and a B.S. in Biology from the University of South Dakota.

Cali Fidopiastis is a Chief Scientist with 15 years' experience in the design and development of military training systems. As Technical Lead for Katmai Corp, she provides expertise for the research and development of INTREMED's conceptual and logical design, as well data management strategies.

Sandra Hughes is a Research Psychologist for the Naval Air Warfare Center Training Systems Division with an M.S. in Industrial/Organizational Psychology. Her work has focused on team training and decision-making, as well as organizational development.

Michael Guest is a Senior Research Psychologist for the Naval Air Warfare Center Training Systems Division.

CURRENT STATE OF MILITARY HEALTH SYSTEM TRAINING AND EDUCATION DATA

The Military Health System (MHS) is responsible for the delivery of operational medicine to enhance the lethality of our military forces and provide peacetime health care. With over 140,000 providers across the world, it is critical to ensure that providers are prepared clinically and operationally to deliver quality care. To guarantee that providers have the necessary skills, it is important to document and track military medical knowledge and performance so that the appropriate training can be provided when new skills are required or when skills decay. However, the MHS currently does not have the data required to determine if medical personnel meet operational requirements[1] or clinical currency requirements. This data is critical for determining whether a provider has the required clinical skills for deployment, especially when delivery of care during deployment is different from their day to day clinical activities. Consider, for example, an obstetrician who will be required to provide emergency care when deployed. It is crucial to understand what skills this physician maintains and which trainings will be required before deployment; it is dangerous to assume that just because this provider is a physician they are prepared to deploy and provide certain types of care. However, the ability to track medical skills and provide this critical information is currently lacking [2] due to decentralized training and education data and poor data quality.

Across the MHS, there are over 100 different systems and websites, with 30 core systems that contain the bulk of the data[3]. These systems were developed independently, operate separately, and have limited means of exchanging data. The lack of interoperability between these systems results in the need to utilize multiple systems separately to document and retrieve status on the training that they capture, with no ability to aggregate the results from these systems automatically. With training spread across a number of systems, it is difficult to see a cohesive 'big picture' of training status, as these data need to be manually exported, aggregated, evaluated and then results must be communicated throughout the leadership chain for action.

The current data infrastructure provide complications for leadership to report on the clinical and operational readiness of the medical force; however, this issue is compounded by the sub-optimal data collected within these systems. While there are ongoing programs aimed at modernizing training and education data (for example, the Navy's Ready Relevant Learning, the Advanced Distributed Learning Initiative's Total Learning Architecture, or the Army's Synthetic Training Environment), existing data in legacy systems is largely limited to the collection of completion status. Specifically, these systems can tell you if training and education was completed or not but do not have additional details on how successful you were within the course or within the subcategories of information that were fulfilled to obtain the course completion. Critical details about the clinical skills and experiences taught within that course and the degree to which they are achieved are lost. This lack of data provides limited insight into the actual clinical skills of the provider, frequently resulting in the dangerous assumption that skills are acceptable because a course or training was completed.

IMPACTS OF CURRENT TRAINING AND EDUCATION DATA ISSUES

The existing decentralized infrastructure and the subpar data quality impact all levels of operation. Use cases were derived from preliminary research to detail these issues at the individual, the MTF, and DHA as the Enterprise.

Individual Level Impacts

Decentralized Infrastructure: Imagine a nurse, CDR Jack Smith. CDR Smith is required to take a number of courses annually: some are required to maintain his license (e.g., continuing education credits), some are mandated by his Medical Treatment Facility (MTF) (e.g., basic life support training), some are required by his Service (e.g., combat care), and others are required by DHA (e.g., HIPPA training). There is no central database to track all of his training, yet he is responsible for maintaining currency on all of them. He must find a way to track his training and ensure he is up to date, either with a paper logbook or with his own electronic tracking system. For much of the MTF-, Service,

and DHA-mandated training, he must provide evidence to the MTF. Depending on the type of evidence, this may go to different offices. For example, evidence of licensure would go to the credentialing office, initial evaluation of core competencies would be completed with a supervisor when arriving at the MTF, and evidence of HIPPA training completion would be provided to the staff education and training office.

Data Quality: CDR Smith will have some insight into his own skillset. However, once a course is over, the specifics of what he learned and how he performed will likely be unavailable once he finishes his course. Furthermore, if CDR Smith wishes to expand his skillset, he needs to be able to self-assess, identify which skills would be most useful given his role, and identify and locate those training opportunities himself. Any data that identifies his existing skills would be unavailable if he wishes to make changes to his career trajectory.

Medical Treatment Facility Impacts

Decentralized Infrastructure: The training and education officer at CDR Smith's MTF is responsible for making sure that CDR Smith, as well as all other providers, have maintained currency on certain military-required training. The officer is also responsible for reporting status to the MTF and to the Service as required. The training officer must check the certificates of training provided by CDR Smith and other providers and record them as compliant on the training in multiple systems as required. For example, the MTF may track all training completed at the hospital in one system, whereas the Service requires a certain subset of those trainings to be maintained in the Service's authoritative database. To check on compliance of personnel at the hospital, the training officer must go into several different systems and export the data from all of them, putting them into an external spreadsheet. Then, a roster is typically exported from a separate system and merged with the training data. This requires manual manipulation to ensure all the data is accurate. This spreadsheet is used as the point of truth for reporting any compliance or delinquencies. If any of the providers are at risk of becoming delinquent, it is the responsibility of the training officer to reach out to the supervisors (as there is no single system with reminders or notifications), who then reach out to the provider to ensure the training is completed. This is a long process requiring many systems, labor hours, and manual manipulation of data.

Quality of Data: For training completed at the MTF, the information that is recorded is generally a course completion, which provides limited insight into the specific knowledge or skills proficiency. For training completed at the MTF, there may be more detailed records of performance beyond the completion status (e.g., if a checklist was used, there may be a copy of that checklist). However, skills checklists are often completed on paper, in which case they are 'lost' after the training is completed in the sense that it is unlikely that somebody will attempt to retrieve these checklists in the future to determine how well individuals performed on any given checklists. For knowledge assessments or skills checklists that are completed electronically (for example, Navy nurses often complete skills checklists electronically through Elsevier), these data are not merged with any system and completion statuses are generally all that are reported on. The MFT may retain records of advanced skills obtained (e.g., if a nurse receives training to administer a PICC line) that is not reported up (e.g., when training is not mandatory, but obtained voluntarily). In these cases, the more detailed knowledge about specific skills stay at the level of the MTF and are lost to the Service. The Service is only likely to have information about specialized or advanced skills if obtaining those skills changes the role or designation of the provider.

Enterprise Level Impacts

Decentralized Infrastructure: Guidance exists from the Services and DHA about what kinds of information must be stored, (e.g., AR 40-68 [4] contains information about documentation for clinical quality, including trainings). However, guidelines typically do not specify a particular database or requirements to store data in a particular format. This means that there is little standardization about how or where records are stored. Many records are still stored on paper. Obtaining any picture of overall completion therefore requires many layers of compiling and reporting up (e.g., individual MTFs compile data from multiple systems, data from multiple MTFs are compiled to report on overall compliance of a market, etc.) This process is time consuming and limiting in the ability to obtain insight into the overall status of medical personnel across the Enterprise. Furthermore, auditors can monitor for compliance to ensure the records are kept but must learn and understand how each individual MTF maintains its records in order to do so.

Quality of Data: The difficulty of evaluating performance is exacerbated at the enterprise level, especially when considering cross-Service evaluation. Consider two important and roughly equivalent roles: the Army Combat Medic (68W) and a Navy Hospital Corpsman (HM). These are both enlisted roles responsible for providing emergency medical care. While there is a largely overlapping set of skills required from these two roles, the requirements for each of these roles are not identical. For example, both require completion of the Tactical Combat Casualty Care Combat Medic/Corpsman (TCCC-CMC) course but an Emergency Medical Technician (EMT) certification is required only by the Army. There is not a single platform at the enterprise level that allows for full visibility of status on requirements and qualifications while taking individual Service requirements into consideration. Even if the data were made available at the enterprise level, it would be limited to completion status tracked in legacy systems. The implicit understanding is that completion status reflects at least the minimum passing score for that training. This data does not provide information about knowledge and performance gaps that could be easily rectified with point of need training. Further, this data may be delayed due to system issues such as failure to upload and save, as well as delays in reporting. This lack of quality data fails to provide a global view of MHS-wide status and the particular clinical strengths and weaknesses of a given role, region, or Service.

CONTEXT OF THIS STUDY

The issues described above result from the data collected within the many disparate training and education systems across the MHS and the quality of that data. The multitude of training and education systems exist because they are procured and used in support of specific objectives aligned to the organization using them and their mission. It was important during this research to respect the purpose these systems serve and not to replace any of them, but to ensure the data from them can be aggregated for quality, reliable analytics for the Enterprise, Service, and Individuals.

The need for centralization of the resulting data has been recognized as an issue across the MHS and is already being addressed by an ongoing effort by the Defense Health Agency Education and Training Directorate (J7) called Interoperability Networking for Training, Readiness, and Education in Medicine (INTREMED). This effort seeks to provide a scalable and extensible infrastructure to standardize and centralize disparate training and education data across the Services and DHA enterprise into a single location. When complete, existing training platforms and Service authoritative databases can remain in place, but through automatic data exchange with INTREMED, can be accessed from a single location. Contrasted with the current state, medical personnel will have a single location to track all training and education requirements; training officers will find all required data in one platform without the need to spend hours "hand jamming;" and both the Service and DHA levels will have automatic insight into status of medical personnel. The technical work required to aggregate all data into a single location and format the data so it can be combined and analyzed is ongoing (NAWCTSD, 2021) and issues with data quality will be discussed further in the discussion.

Centralization and standardization of this data is critical to providing accurate, reliable analytics but only if *relevant* data are included. Countless data elements are collected by existing systems and it's important to aggregate the subset that contribute to necessary performance metrics across the MHS to avoid system overload. The first question researchers sought to answer was *"What are the critical data used for performance evaluation of medical professionals?"* To answer this question, it was necessary to understand what performance data are collected regardless of system or organization, why they are collected, and the overarching purpose. Researchers reviewed current processes, infrastructure, and resulting data and supplemented this information with interviews to understand the data considered critical to performance measurement and the pain points surrounding the storage and retrieval of this data.

After confirming the critical performance data and how they are used, the second research question to be answered was *"Is it possible to standardize the collection of critical training and education data without impacting current training or the mission?"* To this end, a data driven approach was used to cluster critical performance data across the Services and evaluate possible methods of aggregating and standardizing that data. In short, there was considerable overlap in the types of data used to make evaluations across Services: 16 discreet categories of data were identified that were used across Services and roles to evaluate performance. These data are used to evaluate three main

components of care and readiness: licensure and certification (whether or not the provider is qualified to deliver care), clinical quality of care (the proficiency of clinical skills), and battlefield readiness (whether the provider has the required military medical skills to deploy).

METHOD

We conducted a series of interviews with training and education personnel at various levels (e.g., trainers, training and education officers at individual Military Treatment Facilities (MTFs), supervisors, etc.) to identify data elements that are used to evaluate medical personnel. To start, four primary roles were selected that included both enlisted and officers: combat medics/hospital corpsman, nurses, physicians, and physician assistants. These roles were selected to cover both combat and non-combat medicine as well as a variety of roles within the MTF.

Participants

Interviewees were identified primarily through project stakeholders and Service representatives, who provided contact information with training managers or other personnel with experience in training and education. The research team conducted a series of semi-structured interviews with 27 domain Subject Matter Experts (SMEs) who were both medical providers and involved in training, including four Emergency Medicine (EM) Physicians, nine Emergency Medicine (EM) Physician Assistants (PAs), three Navy Hospital Corpsmen, five Navy Field Medical Service Technicians, three Army Nurses, two Air Force Nurses, and two Army Combat Medics.

Procedure

Interviews were semi-structured, although questions were tailored for each interviewee based on their role and Service. Interviewees were asked about how it was determined that a provider was qualified and proficient in their role and the specific data used to make these determinations and the functions that specific data served. For example, physicians are required to obtain a medical degree. This is considered evidence of basic foundational knowledge, but not necessarily that they are skilled at a certain procedure. After several interviews, the data were examined and common categories of data were identified (e.g., for example, a medical degree and a nursing degree are both foundational required educational programs, even though the specific degree is different). As these groupings of data emerged, they were depicted in diagrams aligned to Service and role. These diagrams were presented to past and new interviewees for confirmation and to identify any gaps or errors. The categories of data were explained to interviewees who validated whether the categories were accurate and also provided new categories. Final results were discussed with key stakeholders for further validation.

RESULTS

TRAINING AND EDUCATION DATA CATEGORIES

The data reported by interviewees clustered into common categories based on the functions they served. For example, while nurses and doctors require different specific degrees, they both require a degree that indicates a foundational background of knowledge and skills. This grouping was considered a common category of "initial education program." Sixteen distinct groups of data were uncovered that are used consistently across Services (see **Error! Reference source not found.**). Some of these, such as initial education program and pre-deployment/military training, are used across all roles. Others, such as privileges, are relevant only to some roles (i.e., physicians and PAs).

Table 1. Sixteen Data Categories Across the Military Health Service

Category	Description	Used by	Evidence
Initial Education Program	The initial training (e.g., nursing degree, medical degree, etc.) required to perform the role. Generally culminates in a degree/certificate.	All Roles	Professional Degrees Officer Development Courses
Pre-deployment/military \training	Medical training that is specific to military or deployment needs (e.g., medical air transport). Depending on the course, these may also qualify as continuing education credits.	All Roles	Formal Course Completion Certificates Individual Critical Task List (ICTL) Checklists
Mandatory training (e.g., HIPPA, safety, etc.)	Training required to perform job duties that is medical in nature but does not train clinical skills (e.g., HIPPA training). It tends to be offered online.	All Roles	Formal Course Completion Certificates
Continuing Education	Any continuing education required to maintain certification or licensure	All Roles	Formal Course Completion Certificates, Continuing Education (CE) Credits
Skills Certifications	Certifications, such as Basic Life Support (BLS), Advanced Life Support (ALS), and Pediatric Advanced Life Support (PALS), etc. that are required to work at the MTF according to the role.	All Roles	Professional Certifications
Clinical skills/competency training	Clinical skills training after initial training (not necessarily continuing education, although sometimes military-offered training may qualify as CE). Skills fairs, training offered by the MTF, etc.	Nurse; medic/corpsman	Micro learning Events Task/Simulator performance ICTL Checklists
License/Certification	The license/certification required to perform a particular role.	Nurses, Physicians, PAs; medic varies by Service	State Licensure
Board Certifications	Specialized training certification.	Physicians	Professional Certifications
Privileges	Granted by the MTF to allows individuals of particular roles (i.e., physicians, PAs) to perform certain procedures,	Physicians; PAs	Clinical Privileges

	depending on training and previous experience.		
Supervised training hours	Procedures and contact hours performed during training. Specifically relevant when applying for privileges at the first MTF.	Physicians; PAs	Accreditation Council on Graduate Medical Examination (ACGME Ratings), Entrustable Professional Activity (EPA) Ratings
Procedure count/contact hours	Number of procedures or clinical contact hours with patients performed on the job.	Physicians; PAs	Number of Clinical Hours Logged, Procedure Counts, EMR-Derived Knowledge, Skill, and Ability (KSA) Scores
Patient Safety/Peer Reviews	Peer reviews of charts and any adverse incident reports that may be associated with the personnel.	Physicians; PAs; Nurses	Adverse Events Reviews
Annual Supervisor Evaluations	Any supervisor evaluations that include a reference to the competency of the employee (generally limited to one or two brief sections).	Physicians; PAs; Nurses	Officer Evaluation Reports
References	Letters of reference from prior employers, generally used as part of the privileging process.	Physicians: PA	Letters
Specialty Skills Training	Specialty training that results in a change in role designation or additional codes.	Physicians: PAs, Nurse varies by Service	Specialized Training (Position) Identifiers
Optional Advanced Skills Training	Any training the individual obtains to advance their clinical skills, but is not mandatory for the role (e.g., PICC line training)	Physicians and PAs when it affects privileges	Clinical Privileges

Some data categories are required for all roles, regardless of Service. These include initial education, pre-deployment/military training, mandatory training, continuing education, and skills certification. It should be noted that there is some overlap across some of these categories: specifically, some of the military training can also qualify as continuing education (which is a civilian requirement to maintain currency of the license). Records typically only indicate whether or not these requirements have been met (as well as the completion dates). Records indicating the quality of performance (e.g., grades) are not recorded or are stored outside of the training institution and therefore lost to the MTF and Service.

Some categories are used across Services, but only for specific roles. This includes counts (procedure/contact hours either under supervision or during employment), privileges, patient safety, and subjective evaluations: peer evaluations of charts, any reported adverse events, and references from previous MTFs. Supervisor evaluations may include the option to comment on clinical skills, although this tends to be a very small part of the provider's overall evaluation.

One category where differences emerged across Services was in the requirement of a license, but this differed only for the medic/corpsman role. Most providers are required to maintain a license/certification, but Navy Hospital Corpsman are not required to obtain an EMT certification.

Overall, it was discovered that whether a particular category of data is used to make evaluations was predominately driven by role and not by Service (five categories are captured for all roles whereas 11 categories differed by role). More differences by Service are likely to emerge with further investigation into the 'pre-deployment/military training' requirement, but by and large, the major differences are based around the civilian requirements of how a particular role functions in a hospital. For example, doctors are required to obtain privileges, which requires an accounting of clinical hours or procedure counts; nurses are not and therefore records are not kept. Nurses are trained on core clinical skills more frequently; doctors are generally assumed to have the skills if they have the associated privileges. Privileges (which grants the provider the ability to provide care at the facility) are the primary method of evaluating physicians and PAs, as the process of obtaining privileges requires a review of much of the data described above. This includes including training and on-the job data, such as confirmation of a valid license, letter of reference from a prior hospital, a statement about procedures that the provider is requesting privileges to provide, and an evaluation of medical charts and any adverse events.

REPORTED LIMITATIONS TO DATA TRACKING WITHIN CATEGORIES

Two categories of training were reported as important but not typically tracked: continuing education and optional training. Continuing education is required to maintain a current license, but generally the specific courses taken by the provider are not typically recorded by the MTF or Service, unless it is military training that also qualifies as continuing education. It is generally considered that the MTF needs to know that the provider has maintained their license, and while continuing education is a requirement to maintain the license, the specific courses are the responsibility of the provider. In addition, optional training (that is, not required for the role but sought out by the provider to expand their skill set) is generally not tracked unless it results in a change to privileges or role designation. An example of this would be training on insertion of a PICC line by a nurse. Records of this information would be recorded by the MTF in local databases (which could be as simple as an Excel sheet), but not by the Service. Therefore, these skills are more likely to be tracked for privileged providers.

One issue that emerged repeatedly in these discussions was a need for more on-the-job performance evaluation. Specifically, it is only the privileged positions (Physicians, PAs) that require procedure counts or clinical contact hours to be tracked. Nurses raised the point that the focus of their evaluations tends to be on training, as opposed to on-the-job performance. Tracking actual patient contact is more difficult for nurses, as information about attending physicians is stored in the electronic health record, while this is not true of nurses. Because there is no requirement by the hospital to track contact hours for nurses, there is no record of contact and no basis for evaluations. The nurses we spoke with expressed that this was a serious deficiency in the ability to properly evaluate clinical skills. Furthermore, when procedure counts are required for privileged roles, they are often tracked by the provider themselves. PAs, for example, are expected to maintain their own logbook of procedure counts. Physicians may have the option to request that data to be pulled from the electronic health record. Some of the Air Force Comprehensive Medical Readiness Plan (CMRP) items required nurses to have completed a certain number of clinical hours, but it is up to the nurse to self-report that these hours were obtained. Therefore, even if a piece of evidence is considered important, there is not always an easy or consistent way to track it.

DISCUSSION

Distinct differences have been observed within training and education across the Army, Navy, and Air Force in order to accomplish their separate missions effectively. Given that the tasks, conditions, and standards of the training vary, it was thought previously that collecting a standardized data set across the Services was an impossible task. The results of this effort confirmed that, for the roles investigated, the Services are collecting the same basic categories of data for measuring performance of medical providers. Interestingly, the categories of data used to track personnel were driven most by the requirements of the role: there were actually more differences in the data used across roles than across Services. For example, completing certain numbers of procedures is necessary to obtain privileges; therefore, only privileged roles have a requirement to track procedure counts. We do note that there are other ways these categories could have been meaningfully constructed: for example, foundational knowledge (i.e., initial training, continuing education), hands-on skills (i.e., procedure count); initial vs. ongoing/sustainment education and training. However, the groupings identified here were most relevant for the functions they served for the community of interest.

Uncovering these categories was critical to achieve the goal of aligning training data across roles and Services without changing education and training requirements (see **Error! Reference source not found.** for an example of how data for an individual could be structured and visualized). By identifying data used for performance measurement and grouping these data into categories, it is possible to evaluate whether medical personnel meet their requirements, regardless of whether the requirements are set by civilian standards (e.g., licensure), the MTF (e.g., certifications such as Basic Life Support), the Service (e.g., deployment-related training such as critical care air transport), or DHA (such as HIPPA training). The major advantage to the data-driven approach taken here means that it is possible to capture the spectrum of data that are currently in use to evaluate performance, leveraging existing metrics collected from existing training. Thus, this organizing framework can be used to provide valuable information about performance without making any changes to training. It is also possible to identify and use non-training data (e.g., procedure counts) that form a vital component of performance evaluation. As training requirements change over time, they can be incorporated into the framework and adjustments can be made as needed. This framework is not considered static, but rather a flexible method of categorizing training and performance data that will provide useful information that is currently unavailable.

Data Quality Issues with Performance Tracking

During the course of conducting the interviews, it was revealed that to the extent that information about specific skills and performance quality are available to the MTF, they tend to stay MTF level and are generally lost to the Service or DHA levels. For example, an MTF may take advantage of advanced skills obtained by a nurse and record information regarding the associated training in a local database (often a spreadsheet). Supervisors have an understanding of the skill levels in their department; however, evaluations of clinical skills tend to be very sparse and are not currently in a format that are easily aggregated and reported up. Some providers may perform more administrative tasks and less clinical work and therefore experience some decline in their clinical skills; this information is also not available when selecting teams for deployment. The exception to this is if the advanced skills change the role designation or privileges of the provider. Role changes would be maintained in the personnel record and privilege changes in the Joint Centralized Credentials Quality Assurance System (JCCQAS). Finally, critical context about the clinical environment is rarely captured for interpreting EMR-derived KSA scores. For example, performing the same task (e.g., placing a central line) can be very different for a patient undergoing scheduled surgery vs. a patient undergoing trauma surgery because substantially greater skill is required to perform the latter. All of these examples point to a crucial loss of data transfer from the MTF to the Service. As a result, decisions about assembling teams or assigning personnel to specific missions are based largely on role designation, rather than individual skills or proficiencies. However, there is an opportunity to provide this information to the Services and DHA by digitizing data collection during training and providing more detailed information about training beyond completion status.

Improving Data Quality with Digital Data Collection

The issues with tracking only completion status is that it provides little insight into the actual knowledge and skills obtained and sustained over time. However, learning experiences outside of the classroom are not recorded at all, or are recorded using paper-and-pencil; this makes it very difficult to meaningfully track skills over time as it would require an enormous burden of manual entry: first on paper and then into a system (which are often described as somewhat clunky). Even for classroom and online learning, courses are generally marked as "completed vs. not completed," and detailed performance data are rarely captured. In addition, training courses are typically scheduled based on the passage of time (e.g., a specific course is scheduled every two years) rather than demonstrated levels of task proficiency (e.g., the course is scheduled when the learner's proficiency has decayed below acceptable levels). All of these factors make it difficult to obtain a clear picture of areas where individuals or groups might need remediation before being trusted with providing medical care to military personnel. Moving forward, a clear picture of the clinical skill proficiency would provide a valuable asset to both the Services and DHA. This will require more detailed data than course completion status, which is the most commonly collected type of data to date.

Digital data collection during training and evaluation provides an opportunity to capture valuable information about the specific strengths and weaknesses of particular providers and a more granular level than course completion status. Skills checklists, for example, can be collected digitally, which would both allow data to be maintained and evaluated as well as eliminate the need for entering data about completion statuses into a database after the fact. Checklist tracking can also be used to provide skill assessments. Furthermore, digital data collection allows valuable metadata to be captured and provide context to evaluations. For example, a provider might perform a skill well in a classroom setting, but not in a battlefield training exercise. This discrepancy could indicate further training in combat scenarios would provide a greater benefit than repetitions of the skill in the classroom. The specificity of this type of point of need training may resolve training gaps and allow personalized, targeted training.

Sub-completion data would make the sixteen categories uncovered in this project even more meaningful. For example, using completion status, it would be possible to see in one spot that CDR Jack Smith, the nurse from the introduction, has completed his incoming training required by the MTF at his arrival (which may be represented as completion statuses in the "clinical skills" category). However, by digitally capturing data, it would be possible to see that he is highly skilled at inserting IVs and talking with patients.

Capturing data during training would also provide an opportunity to capitalize on competency frameworks (such as Competency and Skills Assessment (CaSS) [5] or MedBiqutous [6]) which are in development elsewhere. Competency frameworks allow the data generated by a course to serve as evidence of a particular competency. For example, as a learner progresses through a course, data generated from this course would be associated with one or more competencies (e.g., critical care). As trainees successfully move through courses, they can fill a portion of their competency. This approach is a particularly useful way of providing a standard method of evaluating capabilities at a more detailed level than course completion. For example, instead of knowing simply that a trainee completed the Tactical Combat Casualty Care (TCCC Course), it would be possible to identify that they are particularly skilled at applying a tourniquet. When combined with other courses that evaluate the same skill, this convergence of evidence would be a powerful way of identifying strengths and weaknesses. Multiple sources of performance data would also enable immediate and targeted remediation of relatively weaker skills, allowing for more personalized training. This method could provide a useful means of presenting information about knowledge and skills learned during education and training at a more granular level. This approach is different from the one taken in this project, as it would require updating training content to enable appropriate data capture and assignment to competencies (which are also being established by other ongoing work, e.g., Joint KSA working group). However, as training is updated (especially as pen-and-paper data collection methods become digitized), these frameworks can provide a useful way of capturing and visualizing information about individual proficiencies.

Skills checklists, exams, mobile training, and simulators are all examples of datasets that contain crucial information about knowledge and skills but are not being leveraged for storage, aggregation, and analysis. In their current format, it would take a great deal of manual labor to compile and analyze all these data to present a coherent representation

of overall knowledge and skills. However, by digitally collecting these data and aggregating data into a standard format, it would be possible to understand the particular strengths of personnel. The longer-term goals of this project include ingesting and analyzing all these data to provide a comprehensive profile of the knowledge and skills of medical personnel. This detailed information would impact all levels across the enterprise.

Individual Level

Detailed data collection during training will enable new features to make training more efficient for medical personnel. By collecting this information in real-time, training can be adaptive: trainees can spend less time in areas where there is a strong foundation and more time in areas where there is less advanced knowledge or skills. One of the longer-term goals of this project is also to provide the requirements for data driven just in time training recommendations. This could include refresher training for lapsed skills or new trainings to build upon existing strengths, based on career goals. Personnel could identify their long-term goals and the differences between current skill sets and those required for the goals can be automatically identified (with new training recommended to address gaps).

Service Level

The goal for the Services is to provide clearer insight into the specific skills within the Service to in order to make more effective decisions. For example, it would be possible to identify specific strengths at individual MTFs and assign personnel who need those skills to that MTF. Likewise, if an MTF is deficient in a skill that is needed, training could be assigned or personnel who are proficient in that skill could be assigned. More sophisticated deployment decisions could be made based on skills needed rather than (or in addition to) role designations. This would also provide more insight into whether personnel are clinically ready for deployment and, if not, which specific training would be most useful.

Enterprise Level

At the enterprise level, joint teaming and training decisions could be bolstered with insight across Services. Systemic issues across the MHS could be identified at the Enterprise level, and DHA could release targeted training based on need to close those gaps and avoid adverse impacts. Training procurement and development decisions could be based and prioritized according to quantified need across the MHS and the Services, enabling more effective spending. Similarly, strengths could also be capitalized on between the Services. For example, Navy personnel could complete training within the Army if the Army was particularly strong in those skillsets. Joint teaming decisions could be made by compiling necessary skillsets, rather than attempting to identify comparable roles across Services (which will have different requirements). This could enable joint Service teams with the appropriate complementary skills to be assembled for deployment.

CONCLUSION

The data identified in this research show that there is a great deal of overlap in the types of data used to evaluate medical personnel. The sixteen categories of data uncovered here reveal that it is possible to create a standard framework to evaluate all medical personnel using data that are currently collected *without* requiring a change in the way that training occurs. These categories will not solve all of the issues with the current data infrastructure. However, they provide a meaningful way to provide immediate insight into data that are currently used. Over time, as data collection becomes more digitized, more meaningful insight can be gained into the specific knowledge and skills obtained by analyzing more fine-grained data. The framework constructed here can be used and updated as needed to make use of these more detailed information to ensure that the most meaningful data possible

REFERENCES

1. Government Accountability Office (2019). Defense Health Care: Actions needed to determine the required size and readiness of operational medical and dental forces. (GAO Publication No. 19-206).

2. Government Accountability Office (2021). Actions needed to define and sustain wartime medical skills and enlisted personnel. (GAO Publication No. 21-337).

3. Naval Air Warfare Center Training Systems Division (2021). Military Health System (MHS) Interoperable Networking for Training, Readiness, and Education in Medicine (INTREMED) Interoperability Analysis.

4. Department of the Army (2009). Clinical Quality Management (Army Regulation 40-68).

5. Robson, R. and J. Poltrack (2017). Using competencies to map performance across multiple activities. Paper No. 17139. Proceedings of the 2017 Inter-Service/Industry Training, Simulation, and Education Conference (I/ITSEC). Arlington, VA, National Training and Simulation Association.

6. Smothers, V., Clarke, M., & Van Dyck, C. (2006). MedBiquitous and journal publishers: scholarly content and online medical communities. Learned Publishing, 19, 125–132.