

Chapter 15

HEALTH INFORMATION SYSTEMS

MICHAEL J. STONE, MBA, MHA*

INTRODUCTION

DEFINITIONS

- Information Systems
- Health Information Systems
- Health Information Technology
- Telehealth

RELEVANCE OF INFORMATION SYSTEMS TO MILITARY HEALTHCARE PROVIDERS

TYPES OF HEALTH INFORMATION SYSTEMS

PRINCIPLES OF EFFECTIVE MILITARY HEALTH INFORMATION SYSTEM EMPLOYMENT

- Requirements Identification
- Health Information Systems as a Component of a Comprehensive Health Delivery System
- Cyber Security
- Affordability and Sustainability
- Provider and End-User Efficiency

MILITARY-SPECIFIC HEALTH INFORMATION SYSTEMS REQUIREMENTS

- Interoperable
- Operationally Viable
- Sustainable and Dynamic

OTHER HEALTH INFORMATION SYSTEMS CONSIDERATIONS FOR MILITARY MEDICAL OFFICERS

- Procurement and Requirements Definition
- Virtual Health Information Systems in Military Operations
- Dependents in a Joint Military Environment

SUMMARY

**Lieutenant Colonel, Medical Service Corps, US Air Force; Assistant Professor, Department of Military & Emergency Medicine, Uniformed Services University of the Health Sciences, Bethesda, Maryland*

INTRODUCTION

Just as battlefield information is critical to understanding and managing the tactical and operational environment, medical information is critical for the uniformed medical community to conduct essential medical operations. Whether it is a simple communication system such as a handwritten prescription medication order or a more advanced treatment system such as the proper application of concentrated energy to eradicate cancer cells, health information systems (HISs) are

keystones of medical operations in theater and at home.

HISs play an integral role in military medicine. To maximize their effectiveness, medical officers must accurately identify requirements of HISs and constantly work to improve prevention of disease, non-battle, and combat injuries; to enable diagnosis; to mitigate the effects of these illnesses and injuries; to optimize recovery; and to eliminate waste from healthcare delivery procedures.

DEFINITIONS

Information Systems

An information system (IS) is any mechanism whereby information can be communicated and acted on by one or more actors. For example, a checklist created for the week at the office is a system designed to keep individual and team energies and efforts appropriately focused. Epidemiological data comprises an IS designed to focus the limited resources and expertise of the medical and sanitation community on the key points of disease transmission. The data collected can help researchers discern the origin of a disease outbreak and potential action points to end an infectious epidemic. Finally, the magnetic resonance imaging scanner combines information-gathering tools to enable proper application of medical procedures or resources. ISs are primarily comprised of electronic devices but can either include or be completely fabricated of paper and pencil or handwritten components.

Health Information Systems

HISs span a broad range of data management capabilities from locally developed, field-expedient methods to formal, system-wide electronic tools and databases.

The health information system provides the underpinnings for decision-making and has four key functions: data generation, compilation, analysis and synthesis, and communication and use. The health information system collects data from the health sector and other relevant sectors, analyses the data and ensures their overall quality, relevance and timeliness, and converts data into information for health-related decision-making.¹

The primary goal of HISs in military medicine is to exploit information to render high-quality health promotion and healthcare delivery at the right time, in the right place, and using the right resources. The combination of resources that comprise HISs in the Department of Defense (DoD) deliver information

integral to the provision of effective health promotion and healthcare. They also aggregate information to advance knowledge in disease and injury prevention and management.

The DoD uses various health information systems in its effort to provide comprehensive support to the entire community (eg, the TRICARE online patient portal mobile and the Military Health System GENESIS electronic records). The DoD is improving healthcare by investing in new HIS technology, modernizing health record systems, and promoting interoperability among different platforms for improved continuity of care for service members and military beneficiaries.

Health Information Technology

“The application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health-care information, data, and knowledge for communication and decision making”² clearly defines technology. It is a broad concept that deals with knowledge and practical application of tools and systems.

For health information technology, “technology” represents computers and communications elements that can be networked to build systems for moving health information.³ The Defense Health Agency Health Information Technology Office (J6) is tasked with enabling joint, integrated healthcare to the entire DoD community.

Telehealth

Telehealth is a collection of means or methods for enhancing healthcare, public health, and health education delivery and support using telecommunications technologies.⁴ The DoD uses telehealth to help ensure the health of service members and other TRICARE beneficiaries by providing access to care for a wider range of medical conditions and geographic locations, including remote areas where service members may be injured.

RELEVANCE OF INFORMATION SYSTEMS TO MILITARY HEALTHCARE PROVIDERS

Effective health promotion and sustainment, as well as healthcare delivery in military operations, hinges on accurate, timely, and complete information regarding patients, potential patients, and their environments. Prevention of injuries, illnesses, and combat wounds and their early detection, mitigation, and comprehensive treatment and management are heavily reliant upon data and information. Examples of ISs for healthcare include tests for coliform bacteria in a water source, lipstick for marking casualties in mass casualty triage, and the most sophisticated imaging technology pinpointing the location of shrapnel. Simple through highly technical resources are employed as components of ISs that are essential means of preserving health and life on the battlefield.

The impact of these systems is felt from point of injury to home station rehabilitation as patients experience a continuum of effective healthcare without suffering preventable complications, safety violations, or adverse side effects of therapeutic agents. Specifically, data captured at every stage of patient care provides the facts and evidence needed to render care absent adverse drug interactions or other complications that often result from missing data documenting care or medications administered. In addition, patient safety is preserved as the patient makes the journey to return to full health and function thanks to accurate capture of actions taken by medical professionals along the way. Physicians and other caregivers make informed decisions about each step in the patient's treatment, resulting in positive cumulative effects rather than adverse reactions to the unknown. Without some type of IS, a provider

cannot provide adequate care to patients or practice lifesaving preventive medicine that enables military personnel to succeed in their missions.

Military providers, similar to all other healthcare providers, require a means of capturing and maintaining information regarding their patients' health, the risk factors of the environment or military operation, and the ability to share that information with other caregivers and commanders as needed. Military HISs deliver this capability to the provider and enable application of this data resource throughout the military member's service and beyond. It is imperative that military HISs capture all pertinent information for timely and effective health promotion, health sustainment, and healthcare delivery. This includes preventive medicine information such as immunizations, exposure data, DNA repository information, health status, and dental health status; diagnosis; prescriptions; drug allergies and interactions; imaging data; referral results; vital signs; allergies; and operative risks.

There are inherent accountability requirements and epidemiology interests that also drive the need for HISs in the military. The DoD is constantly evaluating the requirement for medical services and weighing options, such as having all home station care rendered in civilian networks with providers activated as military operations require, or sustaining the current military medical operations structure. HISs must be fluid and interoperable among facilities of the uniformed and civilian sides of healthcare in the military health system. Additionally, force health protection efforts are heavily influenced by epidemiological data analysis enabled by effective HISs. These factors highlight the relevance of HISs in the military health system and for the military medical provider.

TYPES OF HEALTH INFORMATION SYSTEMS

As mentioned previously, ISs can be as simple as when a nurse used a tube of lipstick to mark the foreheads of patients as being triaged during the attack on Pearl Harbor. This practice remains today when nurses, medics, corpsmen, dentists, or physicians use marking pens for the same purpose in mass casualty events. Numerous types of HISs may be devised or encountered while practicing medicine in a military environment.

Triage during military operations or disaster response activities requires an IS to enable the effective and timely care of the ill, injured, or combat wounded. The systems currently employed during triage to document patients' medical conditions range from grease pencils on laminated cards to land mobile radio systems to barcode scanning technologies. The application of handwritten information

is the most basic level of HIS. This type of system requires a standard framework (foreheads, forms, standard terms, etc) and documentation resources (lipstick, grease pencil, marking pen, ballpoint pen, human blood, or other media). The requirement is for a simple system of patient category identification to enable proper medical care. Pen and paper, or other manual system of symbols and tools, comprise this basic form of HIS.

With the current level of technology, the electronic health record (EHR) serves as the most commonly recognized form of an HIS. The DoD's EHR has been in development and refinement since at least the early 1980s, with fielding of the current AHLTA (Armed Forces Health Longitudinal Technology Application) system from 2003 to 2004. The DoD released the

results of its selection of vendor for the next generation joint service EHR in 2016, with continued efforts to standardize health records across the services. The vision for this system is one that would accurately document the health status and healthcare activities of a service member, from point of entry into military service through death, within DoD and Veterans Affairs healthcare systems. This requires interoperable HISs such as the VA's choice of EHR systems. An EHR is a system that brings in data from human actors (administrators, laboratory technicians, nurses, physician assistants, physicians, dentists, and other healthcare providers), medical devices, and other HISs to form comprehensive health records. Patients and providers may communicate virtually, and it allows the patient to have clear and accurate information that reduces or eliminates medication or procedural errors. It is typically comprised of computer hardware and software capable of assembling, storing, and manipulating data from various sources. The value and impacts of this comprehensive EHR system are compelling. Today, service members can access health and healthcare information accumulated over multiple assignments in the continental United States or abroad. The information follows them into the Veterans Affairs system for care following discharge or for disability adjudication.

A third example of an HIS is an operating room suite

system. The assembly of computer software, computer hardware, and sophisticated medical devices serve as an HIS to specifically support single or multiple surgical events. These include devices monitoring vital signs, streaming video, tools supplying images, devices performing procedures, and devices directing laser or radiant energy safely and with pinpoint accuracy. This form of system brings together a conglomerate of small and large systems for a specific purpose. The contributing systems may include an EHR and even a handwritten triage system. All of them come together in a unique application of resources as a health system with a limited but critical scope and purpose. This complex system of information gathering, analysis, and directed care delivery resembles the system designed to understand, fix, and destroy the enemy on a modern battlefield. The parallels between the utility of timely and precision warfighting and health sustainment and healthcare is apparent.

HISs are prevalent in military medicine today and have great implications for medical practice. The basic constructs of the various systems are tailored to function under operational conditions. Whether it is a handwritten system, an electronic record, or a highly specialized suite of devices and applications, the ISs available in military and other medicine environments can be characterized by one of these formats.

PRINCIPLES OF EFFECTIVE HEALTH INFORMATION SYSTEM EMPLOYMENT

Requirements Identification

Identification of process requirements for medical transactions is fundamental. At technology symposia for healthcare providers, vendors present their "silver bullet" systems as the solution to all practice needs. If commercial off-the-shelf HISs are acquired without thorough evaluation for military needs, resources will likely be wasted on a solution without a problem or a partial solution for a much more complex set of problems. The military context presents a unique set of environmental and contextual requirements for health systems. Military medical providers and all HIS users play essential roles in formulating the requirements of a desired system. Considerations include identifying optimal pharmaceuticals, surgical instruments, or intensive care devices, among many other criteria. It is critical for medical providers to identify requirements accurately and look for the problems or bottlenecks in procedures. Requirements drive development of HISs and other resources to address specific problems or needs. If this process is followed closely then the analysis of the current system is more likely to result

in system improvements or new system design. These systems should benefit all involved across the entire spectrum of environments in which the IS will be applied now and into the conceivable future.

It is in the accurate study of requirements and problem identification that so many projects fall short. Much like medical practitioners who do not complete a comprehensive analysis of the clinical situation before making a diagnosis, ISs are adopted as solutions to a problem when they really only address a symptom and often create more problems of their own.

Health Information Systems as a Component of a Comprehensive Health Delivery System

HISs are tools applied in concert with other resources and procedures to resolve a problem. The effectiveness of an HIS depends heavily on the procedures followed in a medical practice. For example, if a forward surgical team has very little time to stabilize a patient, then a bedside ultrasound, though a key to rapid diagnosis, cannot by itself deliver the stable patient. The ultrasound may capture gigabytes of data and provide elaborate reports

when the real problem may be that the forward surgical team lacks the means to capture input from multiple devices to pinpoint an effective course of action.

Cyber Security

Cyber security in healthcare is a crucial component of all HISs. The world of networked computers with countless software installations, downloads, uses, and global access presents a dynamic playground for malicious activity. Foreign actors and others wishing mal intent to the United States and partner nations are constantly attacking by means of cyber media. Healthcare provides a soft target for this activity if systems are employed under the naive assumption that healthcare is off limits in warfare. Security against external and internal actors must be a primary consideration for all types of health systems. Current medical devices are also HISs and are not immune from attack because they present entry points to defense ISs residing elsewhere on connected networks.

Recent well-publicized events in which hackers have accessed protected personal patient information or held entire hospitals and healthcare systems hostage by denying access to their EHRs illustrates the extreme vulnerability of healthcare as a target for enemies or malicious actors. Proper active intervention and prevention efforts are critical to safeguarding the integrity and availability of information. Military providers practice in an environment where health information accessibility and interoperability must be balanced by adequate safeguards to prevent security breaches and data theft.

Affordability and Sustainability

On analysis of current battlefield operations, there is a requirement for a patient tracking system that actively functions from point of injury or illness

through definitive care. One of the key principles for effectively addressing this requirement is employment of an IS that is affordable and technologically viable to implement and sustain in a changing military environment. Myriad techniques or forms of ISs could address these requirements, but realistic design as well as project and operation costs are critical considerations. The system must be operationally viable and affordable while delivering the desired capability and capacity. Unfortunately, the sky is not the limit when it comes to ISs. Resources committed to building and sustaining HISs and health information technology compete with all other medical requirements and even the resources available to the warfighting community. It is critical to employ an IS management expert in the resolution of the budget–function conflict for optimal clinical and technical solutions.

Provider and End-User Efficiency

A key complaint about current EHR implementations is that they are very inefficient. Balancing the capabilities that ISs give to the provider, benefit the patient, and meet the needs of the organization or operation is a key principle of effective systems implementation. The drive for accuracy of information and accountability for actions is at the heart of the EHR revolution. Physicians complain that they spend much longer with the EHR than they ever did with patients using a paper chart. They also indicate that the EHR does not improve care. It is focused instead on the information that can be used for better epidemiology and accounting for actions taken, such as medications prescribed or medical history.⁵ Streamlining systems and making them more efficient is an important goal for any effective HIS.

MILITARY-SPECIFIC HEALTH INFORMATION SYSTEMS REQUIREMENTS

The military health system operates in fixed facilities, in forward operating mobile facilities, and at battlefield points of injury. Consideration for environmental and other constraints placed on ISs in military operations must be a priority. For example, some military operations are conducted in areas with excess heat and dust levels that require hardened devices and optimized cooling capabilities. In other cases, devices must be hardened against moisture when deployed to regions with extremely wet conditions. Often, power sources in austere environments are unstable, so information technology must be hardened against power surges to prevent damage to sensitive components. In all of these cases there is a requirement for secure communications that drives a

need for infrastructure and service provision, which are difficult even under ideal conditions. Given the wide range of operational conditions and variables, a military HIS requires a robust design to ensure success. There are three key requirements that enable the successful deployment of any HIS supporting military medicine.

Interoperable

Given joint service and international partner involvement in current and future military operations, the ISs employed to support medical treatment require the capability to easily exchange information. Beyond the challenges of interoperability across the

DoD, military HISs may also need to be compatible with those from partner nations, or at least be able to bridge any gaps.

In the best case, systems would be interoperable and have data and information sharing functionality across various platforms and technologies. This includes provider notes as well as any images or lab results that are rendered in the course of care from point of injury to home station. In a simpler example, handwritten patient records require the use of weatherproof paper and writing utensils.

Unfortunately, interoperability is a major unmet requirement. Electronic HISs are not typically interoperable across military facilities, organizations, or services, or even within a single enterprise in the civilian sector. The DoD and the Veterans Administration are working diligently to establish and sustain interoperable systems to ensure well-managed, cradle-to-grave medical care for service members. This is a vital component to meeting the military-unique mission. The end result would be visibility of all medical actions taken from the start of a service member's career to their death. This not only enables mission readiness but opens doors to epidemiological research that will shape preventive medical practices of the future.

Operationally Viable

Though much of the work done with systems in military medicine takes place in fixed facilities, military personnel are deployed to austere and remote environments where ISs lack the commonly required support systems. Thus, as modeled by the example of using a tube of lipstick to facilitate communication in patient triage, a system must be able to function despite the lack of typically required resources.

There is a finite amount of bandwidth in austere environments, which sometimes may limit data sharing and storage. It is critical that the medical bandwidth

requirement is voiced loud and clear while understanding the warfighter mission needs. Balance among competing requirements is essential for all aspects of military operations.

Modern technology significantly enhances the list of available options. Handheld devices and mobile computing make point of injury care support possible in virtually any location on the globe. This in turn means that patient information can follow the service member back to home station for continuity of care. Of course, the technology must be shielded from or resistant to the elements (heat, moisture, cold, turbulence, etc) as well as the operational hazards such as spills, drops, or bumps. This principle of operational viability highlights the unique requirements of the military health operational environments.

Sustainable and Dynamic

Already a significant challenge even absent the military context, HISs must stand the test of time to be effective. This means the health system must be technologically sustainable and adaptable to changing conditions. The requirement to monitor the care of service members for approximately 60 to 80 years in conjunction with the rapid evolution of technology could prove cost prohibitive. A vital component of achieving a sustainable system is the proactive involvement of medical personnel in ongoing requirements and system development. When ISs are left to administrative personnel to sustain and design, their requirements are prioritized, often at the expense of clinical functionality. Military medical providers should be actively engaged in design and modification of HISs to ensure the integrity and functionality of systems required to effectively support military operations of all kinds. With technology having a lifespan of 2 to 4 years, the systems employed must be dynamic in nature, with the primary goal of seamless continuity in care over a lengthy period of time.

OTHER HEALTH INFORMATION SYSTEMS CONSIDERATIONS FOR MILITARY MEDICAL OFFICERS

Military medical officers should be able to identify key components of ISs, assess the relevance of various forms of ISs in military medicine, discuss the challenges of deploying these ISs into austere environments, and look at specific examples and applications of HISs in the military environment.

Personnel often adapt to the systems the enterprise provides without ever giving input to development or procurement actions. This can lead to the employment of systems that lack the functionality required by clinicians to effectively care for assigned personnel

under a broad range of military circumstances and conditions. Positive engagement and participation in HIS development offers a long-range benefit for all military medical providers and patients through system functional improvement.

Procurement and Requirements Definition

The process of acquiring and operationalizing a system in the joint military environment is lengthy and exhaustive. If done with a clear understanding

of all requirements, the resulting resource will be an effective instrument for excellent healthcare across the full spectrum of military operations. However, lack of focus on or exclusion of requirements in the procurement process results in wasted time and effort when required patient care delivery needs go unanswered. It is critical that medical professionals make time to participate in procurement of HISs so that clinical operations are adequately considered and addressed.

Medical professionals often lament delays in implementing new technology that are seemingly caused by cyber security requirements. This is a misconception born of not considering security early in the procurement or development process. The real danger would be to ignore security requirements and sacrifice the availability, security, or integrity of both health and defense information, facilitating exploitation of the resultant security weaknesses. It is imperative that health professionals take a proactive approach to security and seek opportunities for strengthening security through their chain of command, development committees, or other available venues. Security should be built into systems and devices as they are introduced rather than being added through modification or retrofitting later, which causes operational and financial burdens. Specifically, health professionals must consider the information they are handling and recommend system operating procedures that preserve its availability, accessibility, and security while minimally disrupting the flow of patient care. For example, medical personnel can help safeguard systems by supporting and promoting introduction of proximity cards or biometric log-in components to systems that protect information with minimal disruption.

Virtual Health Information Systems in Military Operations

With current technologies, the military can exploit connectivity on almost any point around the globe to support patient-provider interactions. This can translate to a soldier or marine on the battlefield, a pilot on the flight line, or a sailor onboard a ship far out to sea getting direct treatment from a specialist back at medical center through video conference on a

medic's handheld device. Telemedicine presents military operations with the ability to take a virtual doctor or nurse into some of the most austere locations with no risk to the medical professional. Better still is the resulting level of care available to service members at the point of injury. Pictures (of dermatological conditions, for example) or digital images (of ultrasounds or x-rays) can be rapidly sent to higher echelons of care for analysis and recommendations for treatment or evacuation.

Military medical professionals must continuously think innovatively when it comes to provision of the right care at the right time, and virtual medicine establishes the ability to do so in any place. Security considerations, both generic and specifically targeted to patient protection, are key and should be a point of focus as medical personnel work to improve their reach and influence.

Dependents in a Joint Military Environment

One of the key requirements of any medical system is establishing a pool of skilled providers and a means of maintaining currency in those skill sets. The military relies on health providers to be current in the skills of their specialty when called upon to support operations. The HIS employed in the military has very similar requirements for effectiveness and currency. Family members and other dependents of military personnel provide a population capable of sustaining currency for both the health provider and the HIS through the care provided by military medical professionals. A system that can support cradle-to-grave preventive medicine and healthcare delivery for the extended military family can also do so for military personnel.

HIS capabilities of continuity of care, interoperability, global access, and virtual medical practice are developed and sustained in peacetime to guarantee availability for operations when events require them. Though care for family members does not typically occur in austere environments, it does provide the context for developing solid practice guidelines that are evidence based and patient focused. This is key to effective medical care delivery regardless of the environment.

SUMMARY

From the first instance of military medical care to the present day, HISs have played a vital role in the effective delivery of care. Ultimately, the effective, efficient, timely, and precise protection of human health and the delivery of healthcare is a function of gathering, analyzing, and making critical decisions based on data compiled over time

and space. This information matures into knowledge through context, and is refined into wisdom through experience.

It is ultimately the responsibility of medical professionals to ensure that patient information is available, accurate, and safeguarded, through diligent use of the tools provided by the DoD. HISs are designed to

provide these services and then leveraged to ensure the protection of the community and the military force, and to ensure provision of the best medical care. Skilled healthcare professionals must be actively involved in

identifying clinical requirements, and procuring and sustaining available, accurate, and safe HISs. Input by healthcare professionals is vital to the effective employment of these systems.

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