A Review of the Role of Health Informatics in Supporting the Malaysian Armed Forces Health-care Services Delivery

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ABSTRACT

Military healthcare system is not dissimilar with its public or civilian counterpart. Healthcare delivery requires timely and accurate information from various sources, and it is information intensive. The present advances, affordability, inter-connectivity and integration of information technology has made the utilisation of health informatics vital in supporting the healthcare system. Health informatics focusses the use of information technology in promoting population health rather than of individuals. It provides health-facts situational awareness that is beneficial to a defined population. Thus, application of health informatics in the military healthcare system is apt. The application of health informatics is also observed in many public healthcare systems. Health informatics is often used as a tool to support health promotion and disease prevention programmes. This review article provides an overview of the health informatics discipline in the military healthcare system and compares between paper-based health recording and centralised electronically-linked health information system. The current development, future projections and challenges of applying health informatics systems in the Malaysian Armed Forces Health Services were also reported.

 Keywords: Informatics; Military healthcare delivery; Health information network; MLHR, CENTROMERES, Surveillance systems

INTRODUCTION

Health informatics is a discipline that has only recently became a topic of interest in healthcare delivery system, as compared to other fields in public health or clinical medicine. It is defined as the knowledge, skills and tools which enable information to be collected, managed, used and shared to support the delivery of healthcare and to promote health [1]. It arrives from the word 'informatics', the science concerned with the gathering and manipulating and storing and retrieving and classifying recorded information. Leveraging health informatics is currently seen as an essential alternative approach in ensuring more effective and efficient healthcare delivery.

Historically, global use of computer technology, as opposed to information technology, in medicine began in the early 1950s. The field gained its traction, when computer technology became sophisticated and affordable enough to manage large amounts of data. Pioneering works include the development of electronic health records (EHR), standardisation of data exchange protocols, informatics training programme and early informatics-based medical research [2].

At present, with the advent of advanced data warehousing and analytics technologies, there are tremendous interest to utilize this platform for achieving value-based healthcare delivery as well as the development of high-quality health informatics research and education. Widespread adoption of health informatics, at both the primary and secondary healthcare settings, have been proven successful in assisting healthcare aims such as integrated care pathways, evidence-based medicine as well as protocol driven clinical practice [3].

Healthcare in the Malaysian Armed Forces (MAF) is mainly provided by the MAF Health Services (MAFHS). It is responsible for the MAF health policies and planning. For the past 50 years, it has strived to provide quality healthcare to the military personnel and their dependents. Although there were tremendous increases in medical and information technologies in the 90s till today, there were observations of resistance to change and use of technology in healthcare settings. Medical technological advances used were only concentrated in hospitals, and their uses were independent of each other that limit sharing and continuity of health information across the MAFHS [4,5]. There was limited usage of focused health information technology in the peripheral health centres. Various preventive programmes were performed such as military personnel health screening and specific health promotional programmes, and individuals' health data were mandatorily recorded [6]. However, based on the limitation of paper-based records, the collected health data could only be reported as reports and statistics which comes with various limitations such as lags, incomplete and unreliable. This issues further limit the usage of those health information for the military commanders and healthcare planners.

At present, the Malaysian Armed Forces Health Services is operating with a declining resources allocation and increasing demands for better healthcare [7]. There is also a need for the availability of actionable health information and knowledge for it to provide its services efficiently and effectively. It is observed that the present practice of military personnel health data collection, as well as healthcare centres services statistics and diseases occurrences reporting, which largely performed using a paper-based method, is unable to provide a real-time information needed.

Military-focus health informatics may be a platform for providing this solution.

This paper will review and explore the role of health informatics in the MAFHS, comparison between paper-based health recording and centralised electronically-linked health information system and discussion of the current development, future projections and challenges of applying health informatics systems.

Health informatics in the Malaysian Armed Forces Healthcare System

Health informatics has a great potential in providing a tremendous support to the MAF and the MAFHS healthcare system. Through the usage of information technologies, health informatics can provide a wide range of products and services, that is beneficial for the whole organisation. Services such as real-time readiness and health status monitoring, health performance indicators, disease surveillance, geospatial information system, predictive analytics are examples utilised in similar type of organisations worldwide [8].

The MAFHS has started to embark in MAF-wide health informatics since the early 2000 [9]. However, the project was put on hold due to the high cost of implementing information technology at its early stage. The usage of information technology in the MAF healthcare settings has been initiated, in isolation, at several larger health units. A clinical health information system (HIS) was used since 2003 in the 96 Armed Forces Hospital [5]. The HIS was used to assist in the management of clinical cases within the hospital. Its application is limited only to the hospital planners and practitioners' due to it being isolated. A much wider system was also implemented within the Dental Services Branch of the MAFHS. The MAFHS Dental's Sistem Informasi Automatik Pergigian (SIAP) system was used to managed military personnel and dental patients' cases in the MAFHS Dental Centre facilities [4]. Although SIAP system was used since 1997, its uses still were limited to a single health services within the MAFHS. There is a need for health information system integration and coverage to the whole of the MAF.

This is where the MAFHS Centralised Medical Repository System (CENTROMERES) comes into the picture in the military-focused health informatics. The CENTROMERE project was initiated in 2013, where it is an amalgamation of several health information systems within the MAFHS (**Figure 1**) [9]. The components of CENTROMERES include the Military Lifetime Health Record (MLHR) system, the Clinical Management System (CMS),

The backbone of CENTROMERES is the MLHR system. The system was initiated to provide the foundation of the MAFHS health informatics. The MLHR system provides a military-wide EHR, whereby the military personnel health data was captured at every periodical health screening examination, throughout their lifelong career within the MAF. The architecture of the MLHR system allows integration of various structured health data captured by the compatible HIS (**Figure 2**).

The initial product of the MLHR system is a real-time medical readiness status to be utilised by military commanders. With this vital information, the military commanders have actionable information to deploy ready military units, further improve the readiness status of the units and allocate appropriate amount of resources to do so. This fact-based decision making would make the MAF much more efficient, resilient and effective. This information is provided by utilising business intelligence visualisation. Methodology using visuals would allow better situational awareness if compared to using solely numbers [10]. Furthermore, business intelligence visualisation allows presentation of valuable information per the individuals need.

Paper-based health data recording and reporting

In one form or another, the method of recording health data on paper has served the MAFHS practice successfully for decades. Military personnel health records were maintained and used for continuation of care throughout the personnel services duration until after their retirement
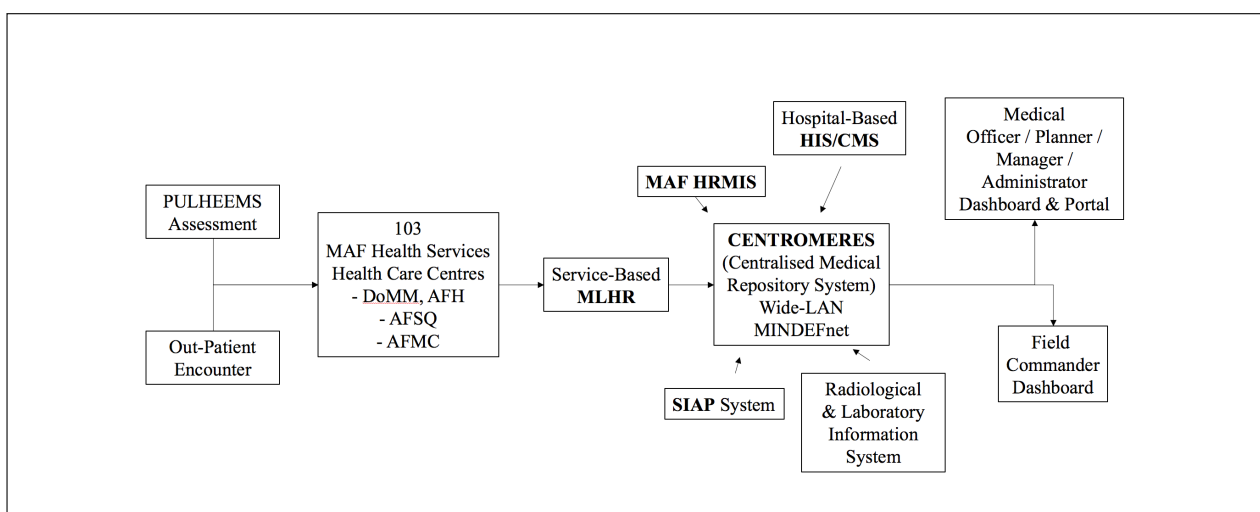

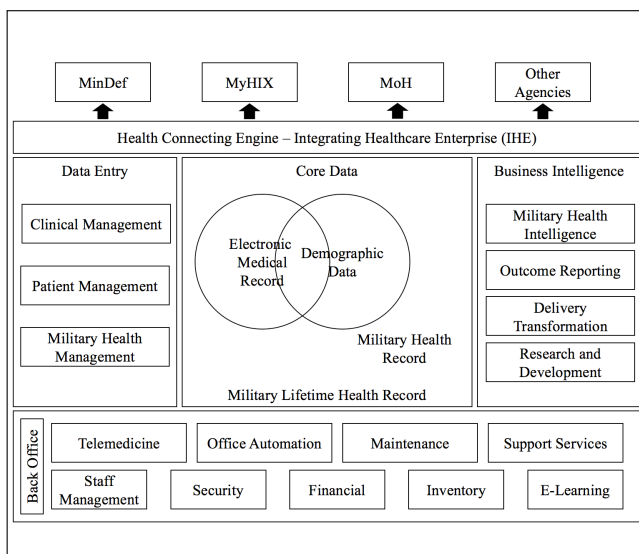**Figure 1 – The MLHR system within the MAFHS CENTROMERES**

Figure 2 – MLHR Architecture Diagram

This type of paper-based recording system has several distinctive characteristics [11]. It allows flexibility in data capture, portability, easy annotation, high-resolution display surface, requires no training, and providing direct access. However, several drawbacks such as physically cumbersome, heavy and difficult to search through for specific information, easily destroyed and the requirement for large storage spaces, limits its uses especially so when it hinders population-based analyses. In the past, monthly health status reporting, which then converted to annual health report, was used as guidelines for the MAF personnel and their dependents health statuses [7]. Issues such as missing data, under reporting and lagging further reduces the impact of these reports for their usage in gauging the MAF readiness status.

Inefficiency in paper-based health data recording and reporting system is compounded by the variation of and lack of structuring of the collected data. In instances of disease outbreaks, dependency on paper-based system added delay in disease identification which then affect response rate and effective management of the problems [12]. It is a known fact that this system would not be able to provide timely actionable health information, and these would not assist in the predicting diseases risks and trends. As the MAF requires transparent and real-time awareness of its personnel health status, there is a need for the MAFHS to seek another platform to achieve these needs.

Modern health information system

All modern health information system, such as the MAFHS MLHR system, relies on computer-based record or usually termed as electronic health record (EHR). EHR has several powerful attributes that are ideal for its usage as HIS tool. Enormous quantity of data can be stored in a small physical space, the ability to create duplicate copies, communicated across geographical areas and the permission for multiple individuals to access a record simultaneously are several of these positive characteristics [11].

Although, the MLHR system demands formal data capturing models that imposes users to conform to its need during data entry, its benefits still outweigh those issues. To counter this problem, the MLHR system planners should anticipate the system properties per their future needs, based on the organization requirement. In the MAFHS, as the mission remains the same, its MLHR System should be able to support the needs of the MAF Commanders i.e. to maintain and preserve the MAF readiness status. All HIS, inclusive of the MLHR system, are standardised. It allows efficient storing, retrieving and sharing of health information within a network which supports inter-operability among different levels of healthcare facilities in the MAFHS. Important shared health data would be easily analysed that provides accurate and timely information for affirmative health action.

Comparison between paper-based and technologically driven information systems

In an information-driven services, such as the healthcare system, the availability of accurate and reliable information is vital. The information must be sufficient and ever-ready to provide a basis for public health or clinical decisions. Paper-based information system has been proven ineffective for those purposes [13]. Data extraction was difficult, there was difficulty of aggregating all relevant data in providing meaningful information, usage of paper-based records incurs further costs in movement, storing, maintenance and labour. The issue of privacy and confidentiality are other major disadvantages known [14]. Access to health data within paper-based records cannot be tracked or traced. In contrast, electronic records clearly have many theoretical benefits over paper. However, any EHR system that have poorly designed record structures could potentially negate the its positive impacts.

EHR system development should focus on several of these measures in other to reap all its benefits over paper-based recording system [15]:

- Accuracy – The extent to which data report the state of affairs truthfully and are free of identifiable errors.

- Accessibility – Easily found data items, with robust mechanisms in place to limit access to only those individuals who are legally entitled to see the record.

- Comprehensiveness – Inclusion of all required data items.

- Consistency – Recording of data in the same way and with the same meaning across records.

- Currency – The degree to which data are up-to-date.

- Definition – The clarity of understood meaning of any given data type (e.g. contrast the ambiguity of the data item labels 'systolic blood pressure' with 'pressure').

- Granularity – The level of detail with which attributes and values of data are defined.

- Precision – Related to accuracy, the degree to which data values truthfully record the state of the world.

- Relevance – The extent to which data are useful for the purposes for which they were collected and do not provide unneeded information.

- Timeliness – Whether the data are available within a useful time frame.

EHR impact evaluation could be performed from a variety of different measures such as user satisfaction, the amount of time spent on different clinical tasks, the completeness and quality of the data that are captured and work flow efficiency.

Application of health informatics in the Malaysian Armed Forces Healthcare System

There are many possible application of health informatics in the MAFHS (**Figure 3**). Stakeholders of the MAFHS, such as Services Commanders or the MAFHS Directors, could use health informatics to monitor health indicators and patient-safety quality assurance. Furthermore, the function of Public Health domain would be more agile as it has a better tool to execute its disease surveillance, disease notification system. Health informatics could be considered as a leveraging platform for the MAFHS services. These are few possible examples of health informatics application in the MAFHS.
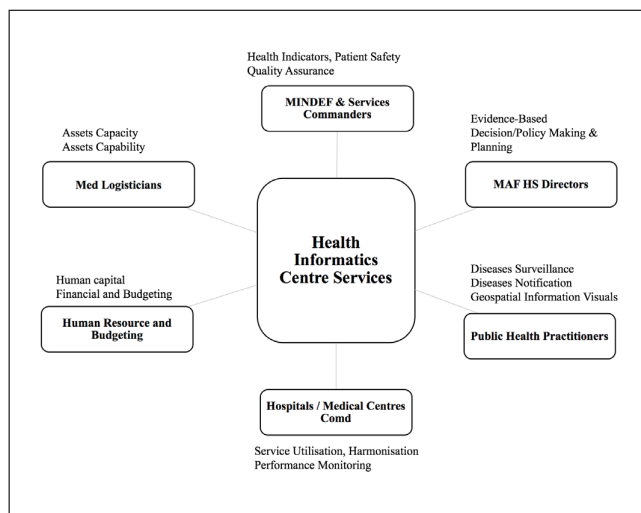

Figure 3 – Applications of Health Informatics in the MAFHS

These applications mimics what is at present needed by the MAFHS for it to discharge its services in an effective and efficient manners. Furthermore, by utilizing health informatics, the action to be taken by the stakeholders would be more meaningful as the information obtained is transparent, current, complete, valid and reliable. With caveats that the data collected from all identified sources are ensured its quality.

In its application, health information could be in disseminated the form of:

- Pre-defined dashboard visualization as normally used by the business system, the Business Intelligence tool.

- Fixed-format form, per the standards used by the MAF.

- Ad-hoc query, where there is a need to aggregate health data by certain individual characteristics.

- Predictive analytics, especially useful for the health planner in knowing whether a certain health programme instituted is beneficial or successful.

To note, there is no generic solution in health informatics. Each system solution must be based on a clear and specific objective. Thus, it is the onus of the MAFHS to prioritise the area for it to focus on when embarking this new approach in delivering health care. Scarce resources make the decision making more difficult. However, accurate and reliable information is also a commodity that will at a longer-term proof beneficial to the service.

Future direction of health informatics

Now, there is a strong drive to equip the MAFHS with organization-wide health informatics system. A legacy system such as paper-based health recording system should be slowly phased out whenever the EHR system has fully matured. The maturity of any health informatics system means that all the three components of manpower, material and methodology have reached an epoch whereby the system is able to deliver its product per the satisfaction of the MAFHS stakeholders.

In order for the MAFHS to be ready in embracing health informatics, it needs to fully support it by:

- Forming an official MAFHS Health Informatics Centre (HIC) within the Health Division of the Health Services Department armed with clear terms of references.

- Staffing of the HIC to include Public Health Specialists trained in Health Informatics, IT Specialists equipped and proficient in software development, database management, network and system security, and Data Analysts capable to produce meaningful outcome based health information e.g. disease incidence, prevalence, risk, geographic information system.

- Support staffs to man the HIC operation centre, supporting all the Health IT system used by the MAFHS. These staffs must be co-located and those who were trained in each of the Health IT system deployed.

- Platform to disseminate all the actionable health information to the stakeholders.

For the moment, there is a pressing need to tackle all the teething issues found following the completion of the MLHR system development. These include, strengthening system usage policy, training of staffs, improving coverage and accessibility as well as speed and completeness of health data capture.

For example, there are still quite a number of health centres outside of the MINDEFnet coverage. A right solution needs to be found for the MLHR system to succeed. Health centres that are not served by the MLHR system will most likely unable to feed in real-time health data to the global knowledge of health status within the MAF.

The MAFHS health informatics need not only data sources from the MLHR system. Sources of health data from the hospital-based HIS or CMS and the SIAP system would give a bigger picture regarding the MAF state of health. Their integration is vital. When this integration has been fully achieved, the MAFHS would have a strong system for it to be able to plan its health services in a more effective and efficient manner.

By having all the relevant actionable health information, the MAFHS is ready to embark further on its quest for the value-based care concept. Health informatics would be able to provide the planner with valid and reliable health outcomes measure. When compared with expenses put in for some certain therapeutics, the MAFHS can gauge and compare the level of efficiency of the therapeutics. Health planner will then be able to put scarce resources for a better used with the aim to achieve the highest impact on the MAF personnel health.

As the amount of health data accumulated would be increasing, research could be initiated to find the right model for disease prediction. Disease risk modelling is another venue where health informatics would be able to assist the clinician. Relying on disease risk model, for practice, from well-established sources is acceptable. However, as there is a wide variation of population characteristics where those risk model was developed, it may not be valid for application in the MAF population set. A customized disease risk model could avoid this pitfall, and health informatics should be able to assist in developing these models.

At the end of health informatics spectrum is the notion in provision of tailored health information system to the individuals. This effort is normally termed as personalized medicine. Tools developed, such as personalized health information portal and smartphone apps that have built in prediction algorithm and notification, would be useful to the MAF personnel in managing their own health. Interaction between health care providers, health care centres would be seamless, providing better coverage and accessibility. At the end, it may improve every personnel wellbeing.

Challenges of adopting health informatics

Applying health informatics organization-wide is not an easy task. There are challenges that need to be aware of, and be readied to mitigate them. These challenges include ensuring the security, safety and confidentiality of the military personnel health data. Now, all MAF military personnel health data is bounded by the Malaysian Personal Data Protection Act.16 Thus, it is vital that protection of health data is put at the highest priority. Mitigation activities should include awareness and training, continuous auditing trail and a comprehensive system policy.

System users and military commanders need proper training in

using any health informatics system [17]. Through the proper usage of the system, the health data generated can be used with confidence and this will ensure the validity of the health information generated. Training programme developed need to be developed specific to the needs of the system user or the military commanders. Training activities must include system flow process per the routine process performed by the trainee at the clinic settings. At the end of the training programme, the system user would have a dependable skill set to operate the system with confidence. For the military commanders, they need to be made understand the presentation and meaning of any business intelligence visualization generated by the health informatics system.

Presently, most the MAFHS is using paper-based health data recording. This legacy system posed a challenge in conversion of its data to any newly developed EHR system. An exercise to convert the legacy system will pose problems such as incompatible data structure, ineligibility and inaccessibility of collected data and the handling of graphic data. In order to fully convert those data will consume man-power, time and expenses. Perhaps, a policy to be developed to cater both the legacy records and the new EHR, until a time where every military personnel health records is captured from the time they enter the service.

Health informatics system rely on the usage of technology. This means using physical information technology apparatus such as workstations, servers, data storage, and networks. These components will eventually be degraded in its functionality as the rate of data streaming in is increasing as well as the amount of data stored. An organization that adopts the health informatics system needs to predict when and where the limitation will eventually happen. Thus, maintenance and upgrading of the system must be planned and supported. Adopters of IT in health care delivery system must be aware of certain pitfalls which may lessen the impact of health informatics. These pitfalls are:

- Recurrent downtime of system networks.
- System interface issues.
- Computer system too slow.
- Software issues.
- Output or display error.
- Output devices down or unavailable.
- Data capture down or unavailable.
- Data loss.

Although there are other challenges shared by other military organization that is using health informatics system, [17] those described are the most important challenges that need to be aware and prepared for.

Conclusion

The future of the MAFHS healthcare delivery looks promising

Although, health informatics have been sidelined, through the present direction and initiatives, it would become an essential platform for the service to successfully completed its mission. A widespread adoption of this platform, which must involve military commanders, healthcare planners, clinicians, healthcare workers and the military personnel itself, would also allow the service to achieve several key healthcare objectives such as seamless integrated care, evidence-based medical practice and protocol-driven care. Present proponent of health informatics must be able to prepare an effective plan to ensure that service would be useful to the larger community. Furthermore, building on the present effort, any future advancement of health informatics, such as text and image mining, personalised medicine, robust clinical decision support system, would allow a more focus and flexible personnel-centred care delivery in the military healthcare system.

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