Ecosystem of e-EMS Online Services
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Abstract - The ecosystem presented in this paper is part of the research project “Business risk management of hospital information technology in emergency healthcare.” This project aims to support emergency medical services (EMS) staffs at the incident location from any remote area of Bangkok by integrating online electronic medical records (EMR) to provide patient’s information on hot-spot for physician’s decision. The increasing number of Medicare claims and the shortage of specialized emergency physicians bring about huge problems for the public healthcare system. Higher treatment cost efficiency and treatment quality shall be accomplished by the ecosystem of integrating Medicare; insurance policies, EMR; tactical patient’s information, and EMS; vital signs, auscultation, telematic support and video material from the emergency site. This research proposes the model of e-EMS online services with the crucial requirements and an essential integrated ecosystem of hardware, software, and data communication networking system architecture which supports by EMS and EMR systems.

Keywords - e-EMS, Electronic Medical Records, Emergency Medical Services, Online Services

I. INTRODUCTION
EMR refers to a patient’s medical record which created, stored, retrieved, accessed, updated, deleted, copied, and distributed digitally, as opposed to the legacy paperbased health record. EMR is the essential section of information in realizing ehealthcare. It may record medical data such as picture archiving and communication system (PACS) which creates in various medical imaging instruments including Xrays, ultrasound, mammograms, computer tomography, magnetic resonance, positron emission tomography (PET) and endoscopy via digital imaging and communication in medicine (DICOM) [2]. EMR includes observations, laboratory results, imaging reports, prescriptions, discharged summaries, and known allergies. EMR is becoming a vital part of hospital information systems (HIS) [3], subsequently the institution of a cognitive, successful, and highly acceptable EMR system will help healthcare professional to improve efficiency, effectiveness, reduce medical errors, reduce respond time of medical diagnosis and treatment, and increase customer’s satisfactions [4]. Deployment of EMR could be leaded to better diagnosis and treatment quality, enhance patient care, clinical services, and more efficient healthcare. According to clinical data of EMR and the evolution of computer technologies, internet and web applications, clinical data quality, privacy and safety quality are both significant issues in and ecosystem of e-EMS online services. An EMR and HIS evaluation methods were driven from IT and IS technologies. Privacy and security information are the foremost concern of patients and the biggest impediment to ehealthcare deployment. The hot topic on privacy issues, conflicts from the functional requirement must be considered into account. One such obligation is efficient and effective response to EMS.

The design of e-EMS ecosystem is conceived to be complex in term of highly confidential medical data are the basis for almost all operations. The creating, modifying, deleting, storing, distributing, accessing, and sharing of such EMR need
conforming regulations [5]. Moreover, the training and educating of medical personnel are likewise important to guarantee compliance with regulations and privacy policies.

Quantitative benefits after integrated implementation between emergency medical services and electronic medical records (EMR) can be identified as the cumulative reduction in overhead expenses documented, life and time saving in clinics and hospitals. EMR systems as Lean process help hospitals manage rooms, physicians, nurses, pharmacy, and operation costs more effectively through increased patient’s satisfaction and improved medication management. While physicians are assured of prescribing the most cost-effective and appropriate drugs and treatment, with direct access to plan-specific formularies and patient drug history at the point of incidence.

In this paper, researcher proposes an ecosystem to secure EMS system, based on identification and verification, to enable secure sharing of sensitive patient’s information during interoperability and preserve patient’s information privacy. The research proposed integrated e-EMS and EMR systems is demonstrated to fulfill goals identifiable to the cooperation ecosystem of entire online national healthcare systems [6].

II. METHODOLOGY

The research was conducted by using case study of 8 Thailand hospitals. Researcher defined emergency medical services (EMS) comprised of three dimensions; HIS; EMR; and biometric identification. At policy management level; five organizations have been interviewed: Ministry of Public Health (MOPH); Ministry of Interior; National Health Security Office (NHSO); The Institute of Hospital Quality Improvement & Accreditation (HAI); National Health Commission Office (NHCO); and Health Systems Research Institute (HSRI). Mainly the questions asked for emergency department on “how to improve emergency services by applying the latest IT technologies.” This research was conducted through literature reviews, international standards (ISO), healthcare standards, physician experts and technology vendors of each organization, as demonstrated in Fig. 1.

At practitioner level; 4 public and 4 private hospitals have been observed and investigated on existing processes, IT technologies, and patients’ satisfaction levels by direct interviews and questionnaires. Each group of hospital was selected; 5 doctors; 5 nurses; 10 admin staff’s support; and 20 patients at hotspot.

![Fig. 1 Framework of research methodology](image-url)

III. SYSTEM DESIGN

The structural design model is based on a central registry and identification that maintains metadata describing every published information. The registry is responsible for answering questions about information meeting restricted criteria, but it does not really store the information. The biometric identification is a mechanism to validate the existing of patient’s records and physician’s authority that allow to access metadata for medical proposes [7]. The metadata includes information about where to update or retrieve digital documents which are stored in repositories (Data Center).

A. Ecosystem Design of e-EMS

Integrating architecture of healthcare enterprise, an EMR system is not possible without interoperability among the various systems which compels using various
standards such as DICOM, the Health Level Seven (HL7) standard, and other medical coding standards provide common vocabulary and semantics [1]. Fingerprint (biometric) is one type of digital image processing in PACS that uses for identify personality in this research case. Patients and physicians can identify personality based on the structure or action of bio-physical characteristics (printed forefinger on both hand right and left) which all Thai citizens already register when they were requested for their ID card. All data based are already stored under Ministry of Interior (MOI). The identification process employs from patients or physicians scanning their right hand forefinger first if identify resulted is “Yes” the system will retrieve their information, as shown in Table I, from MOI data based, when the resulted in “No” the second left hand needs to proceed till the answer is “Yes”, as demonstrated in Fig. 1.

The framework of ecosystem process flow of EMS starting from emergency patient comes to ED with unconscious, thus the system can identify them by EMS (finger scan system) connecting to MOI to verify their personality and sending information back to EMS system by online. In this case is for the new patient that does not have EMR before but for old patient the process flow will be started as 1->5->2->3->4->5. The EMS system of each hospital shall update information everyday to MOPH as 5->6, as illustrated in Fig. 2.

**TABLE I**

<p>|MAPPING INFORMATION BETWEEN MOI AND PATIENT’S PUBLIC INFORMATION|
|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>City Information (MOI)</th>
<th>Patient’s Public Information (MOI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Forefingerprints</td>
<td>Right Forefingerprints</td>
</tr>
<tr>
<td>Name</td>
<td>Name</td>
</tr>
<tr>
<td>Age</td>
<td>Age</td>
</tr>
<tr>
<td>Blood Type</td>
<td>Blood Type</td>
</tr>
<tr>
<td>Emergency Contact</td>
<td>Emergency Contact</td>
</tr>
</tbody>
</table>

**B. Hardware Distribution and Network Architecture**

The existing system of HIS of each hospital is different from each other and the best we can do right now on EMS is only checking patient’s right verification, as depicted in Fig. 3.

EMR online system that produces information relevant to the patient’s care such as laboratory, cardiology, or radiology reporting and billing systems while integrated with ecosystem of e-EMS was designed and constructed a guideline as a stepping stone for MOPH to consider as standardization for applying to deliver a basic e-Healthcare of National healthcare services in Thailand.
The new proposal model of e-EMS online services aims to apply and integrate especially among medical practitioners, medical devices, and internet communication technologies, as demonstrated in Fig. 4. The most important concerns are speed, accuracy, safety, security, privacy, confidentiality, availability, and reliability that have to be ensured in the system design subject to:

- the speed and accuracy of patient’s information before physician given diagnosis and treatment,
- the safety from interception of patient’s related data such as known allergies, hemophilia, etc.
- the prevention of unauthorized access to the systems,
- the data privacy and confidentiality of practitioners and patient related data.

IV. DISCUSSION

The framework of e-EMS online services is a part of national health information exchange (NHIE) and national health information infrastructure (NHII) for integration nationwide medical services [10]. Identification and authentication is very important part of safety, security, privacy, and confidentiality of patient’s information. Biometric authentication becomes significant process to secure access, update, and retrieve patient’s information. Based on evidencebased management (EBM), this could be used to generate and estimate the required supervision information in e-healthcare administration [11].

V. CONCLUSION

Electronic medical records (EMR) are employed in place legacy paper-based systems to increase physician efficiency, effectiveness, reduce costs, eliminate medical errors, improve data availability, and distributing and sharing, etc. Adoption to e-EMS with EMR services get faster when interoperation meets the Hospital Accreditation (HA) standard. Delivery efficiency of e-EMS is significant in save a lot of lives, reducing mortality and disability rates [8], [9]. Thus this research can be taken as a fundamental for the e-EMS integrated with EMR system development to increase speed respond to medical diagnoses and treatment, privacy, safety, security, and confidentiality of patient’s information, availability and reliability for physician’s 24x7 hours to support emergency department (ED).

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REFERENCES


Fig. 4 Framework of national e-EMS online services