Computerisation of accident and emergency departments in Hong Kong

JTS Chan

This article reviews the history and progress of the computerisation of accident and emergency departments in Hong Kong. The Hospital Information System was the first computerisation project to be launched in a public hospital in Hong Kong, when the Princess Margaret Hospital was selected as a pilot site in April 1991. The network infrastructure comprised a central processor that linked to all workstations in the hospital in an integrated network. With the introduction of bar-coding technology and the implementation of an interfaced network, the Accident and Emergency Information System version 1.0 was launched at the Prince of Wales Hospital in March 1993. A Clinical Management System was then piloted at the Accident and Emergency Department of the Alice Ho Miu Ling Nethersole Hospital in December 1997; it contained clinical data of individual patients, including diagnoses, drug treatments, discharge summaries, allergies, and medical histories. Laboratory, diagnostic radiology, and electrocardiography results were also available in this system. With the extensive development of Internet technology within the Hospital Authority, clinical information can now be retrieved in any hospital in a couple of minutes. The availability of important clinical information will be of great help to emergency physicians in the delivery of quality care to patients.

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Introduction

In September 1980, the need for hospital computerisation was endorsed by the Medical Development Advisory Committee of Hong Kong. In December 1982, the Finance Branch approved funding for a hospital computerisation strategy study. In 1983, a feasibility study made the following recommendations[1]:

(1) To develop a centrally integrated regional network;
(2) To develop five modules, namely, patient transaction records, out-patient appointments, laboratory information, order entry, and a patient index; and
(3) To select the Princess Margaret Hospital (PMH) as a pilot hospital.

In 1987, the most popular computer network infrastructure worldwide was a powerful central mainframe computer that served a group of workstations in an integrated network. Commands from all workstations would be processed by the same central mainframe processor. The response time, however, would be long if too many requests were received at the same time.

In November 1987, funding for the Hospital Information System (HIS) of the PMH was approved and the PMH Project Team was formed in May 1988. More than 200 terminals with printers were linked to a mainframe (International Business Machines [IBM] 3090; IBM Corp., Armonk [NY], United States), and 2000 users were trained to use the system. In phase I of the development of the HIS, the major focus was on basic medical operational issues, management, and executive decision support. Timely statistical information such as hospital bed utilisation, bed occupancy rate, average length of stay, admission, attendance, and birth return could be obtained. Five modules were developed in April 1991: a patient master index; admission, discharge, and transfer; laboratory information system; laboratory result reporting; and out-patient appointments.[1]

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Development of the Hospital Information System

At the time of the development of the HIS, the PMH had 1364 hospital beds and an average of 250 in-patient admissions a day. The daily attendance at the Accident and Emergency (A&E) and Specialist Out-patient Department was approximately 450 and 1000, respectively. The average number of laboratory requests a day was approximately 2200. The A&E Department of the PMH participated in the HIS computerisation project, in an attempt to modernise and increase the efficiency of the conventional manual registration system. The computerised registration system helped the department avoid long queues at the registration counter and reduce confusion due to illegible records, especially during busy periods, when the chances of making duplicate registrations were high. By using the Admission, Discharge, and Transfer System, the A&E staff were able to reuse all previous demographic data, thereby expediting the admission procedure. The bed status in each ward could also be readily retrieved and viewed on computer terminals, so telephone enquiries about bed availability were no longer required.

The computerisation project also helped the A&E follow-up clinics in their organisation of laboratory records. Before computerisation, test results were filed manually according to their arrival date from the laboratory and then filed again with the appropriate A&E record. If files were misplaced, laboratory tests had to be repeated, which wasted resources, increased patient suffering, and duplicated effort. By implementing the Laboratory Information System and Laboratory Result Reporting System, A&E staff could readily access the status of laboratory tests and hence avoid repeating tests unnecessarily.

Another advantage of the computerisation process was the on-line booking of out-patient appointments from computers in the PMH A&E Department. The electronic booking system superseded the on-site registration process, thus saving patients a 5-kilometre trip from the PMH to its Specialist Out-patients Department in Kwai Shing.

The Accident and Emergency Information System version 1.0

The HIS was basically a management information system. Its clinical application was still in its infancy because of the problem of data capture. It was believed that data would be of higher quality if they were recorded by clinical staff. Furthermore, the amount of data to be handled was expected to be large. Thus, new computer technology had to be incorporated to meet the demand. Bar-coding was a new technology known as automatic data capture or automatic identification.[2] The primary purpose of this technology was to use a bar-code scanner to capture data rapidly and accurately. The network infrastructure was also changed from an integrated network to an interfaced network.[3] In the integrated network, one central processor served all workstations in the hospital, whereas in the interface network, several processors served different groups of workstations. This system was more flexible, and efficiency was greatly enhanced.

The Accident and Emergency Information System (AEIS) version 1.0 was the first computer-based real-time clinical database capture and retrieval system to be implemented in a public hospital in Hong Kong. The system design and program development were performed by clinical staff, and bar-coding technology was used to enhance data capture. This system was introducted in the A&E Department of the Prince of Wales Hospital on 15 March 1993. At that time, the Prince of Wales Hospital was an acute regional hospital with 1376 beds and an average daily attendance to the A&E Department of 650. One year later, the AEIS version 1.0 was successfully extended to four major A&E departments in Hong Kong: at the PMH, the Queen Elizabeth Hospital, the Tuen Mun Hospital, and the Pamela Youde Nethersole Eastern Hospital.[4]

The hardware requirements for the AEIS version 1.0 were not sophisticated. The system consisted of a computer server (ie a dedicated main computer) and workstations that were linked by a local area network (LAN). This system was in turn linked to the Hospital Authority Data Centre, which is situated at the Kwai Chung Hospital. The Microsoft Disk Operating System (Microsoft Corp., Redmond [WA], United States) was used as the software platform and LAN Manager version 2.1 (Microsoft Corp., Redmond [WA], United States) was used as a communication tool. The application program for database management was Clipper version 5.1 (Nantucket Corp., California, United States). The total cost of this project for one A&E department was HK$300 000, inclusive of the cost of cables, power port, one computer server, and four workstations. The recurrent annual cost was about HK$60 000.

The AEIS version 1.0 comprised four modules: a patient discharge module; an A&E follow-up module; an observation ward module; and a 'special cases'

module (Table 1).[5] To enhance data capture, variables such as doctors' codes, triage categories, disposal destinations, specialties, and trauma or non-trauma cases, were converted into a bar-code format. The users could use the bar-code scanner to capture data conveniently by scanning the bar codes instead of by manually entering data into the computer.

As the daily attendance at A&E departments in Hong Kong was high, ranging from 300 to 900 per department, searching for a patient's location was often difficult. However, patients could be located quickly through the ad hoc enquiry function of the AEIS. Because of the efficient data-capturing process, less time was spent doing clerical work, which allowed more time to be available to communicate with the patients and their relatives. Furthermore, the computer could generate many reports (Table 2), which could help the department to streamline services according to public demand. Data captured by the AEIS version 1.0 was processed every day. The information compiled could give important directions about health care planning, protocol management, knowledge base, resource allocation, policy changes, quality assurance programmes, and clinical research.

The Accident and Emergency Information System version 2.0

In the AEIS version 2.0, Internet technology was also developed. This network, however, was separated from the outside world for security reasons. This network was called the 'Internet within the Hospital Authority' or the 'Hospital Authority Intranet'. The network infrastructure of the Internet is very flexible. Different types of hardware and software can communicate with each other if they conform to the same communication protocol.

The A&E Intranet was first run in September 1997. With the help of this intranet network, many applications could be developed. The first of these was a disaster module to avoid overloading a single hospital during a disaster—that is, to divert victims at the incident site to different hospitals for treatment. Regardless of which A&E department the victims go to, if they belong to the same disaster group, their data will be merged into a single file. As a result, a complete set of updated information about all victims in different hospitals can be retrieved, which is very important in disaster management.

Table 1. Data captured by different modules in the Accident and Emergency Information System version 1.0

Module	Information held
Patient discharge module	Date and time of discharge Triage category Doctor in charge of patient Disposal Specialties Trauma/non-trauma case Site of injury Type of injury
A&E follow-up module	Diagnosis Past health Allergy Medications Appointment Sick leave
Observation ward module	Date and time of registration Date and time of discharge Diet order sheet Bed number allocation
'Special cases' module	Ambulance booking Anti-tetanus toxoid injection Animal bite and anti-rabies vaccination Battered child or spouse Born before arrival Dead before arrival Psychiatric admission Minor operation Poisoning: food or general Plaster of paris used Special procedure/s Staff attending accident and emergency department

Table 2. Reports generated by the Accident and Emergency Information System version 1.0

Report	Information held
Shift handover report	Attendance/admission summary for each shift of duty
Attendance statistics	Daily attendance by sex and age Hourly attendance by sex and age Emergency admission by specialty Clinical admission by specialty
Discharge statistics	No. of discharge by triage No. of discharge by specialty No. of discharge by disposal No. of non-trauma cases No. of trauma cases No. and types/sites of injury
Utilisation statistics in observation ward	Observation ward utilisation report
Statistics of special cases	Ambulance booking report Anti-tetanus toxoid injection report Animal bite and anti-rabies vaccination monitoring report Battered child and battered spouses report Born before arrival report Dead before arrival report Psychiatric admission report Minor operation report Poisoning (food) report Poisoning (general) report Plaster of paris report Special procedure report Staff attending accident and emergency department report
Quality assurance programme	Non-schedule reattendance within 48 h Medical officer performance appraisal Total service time

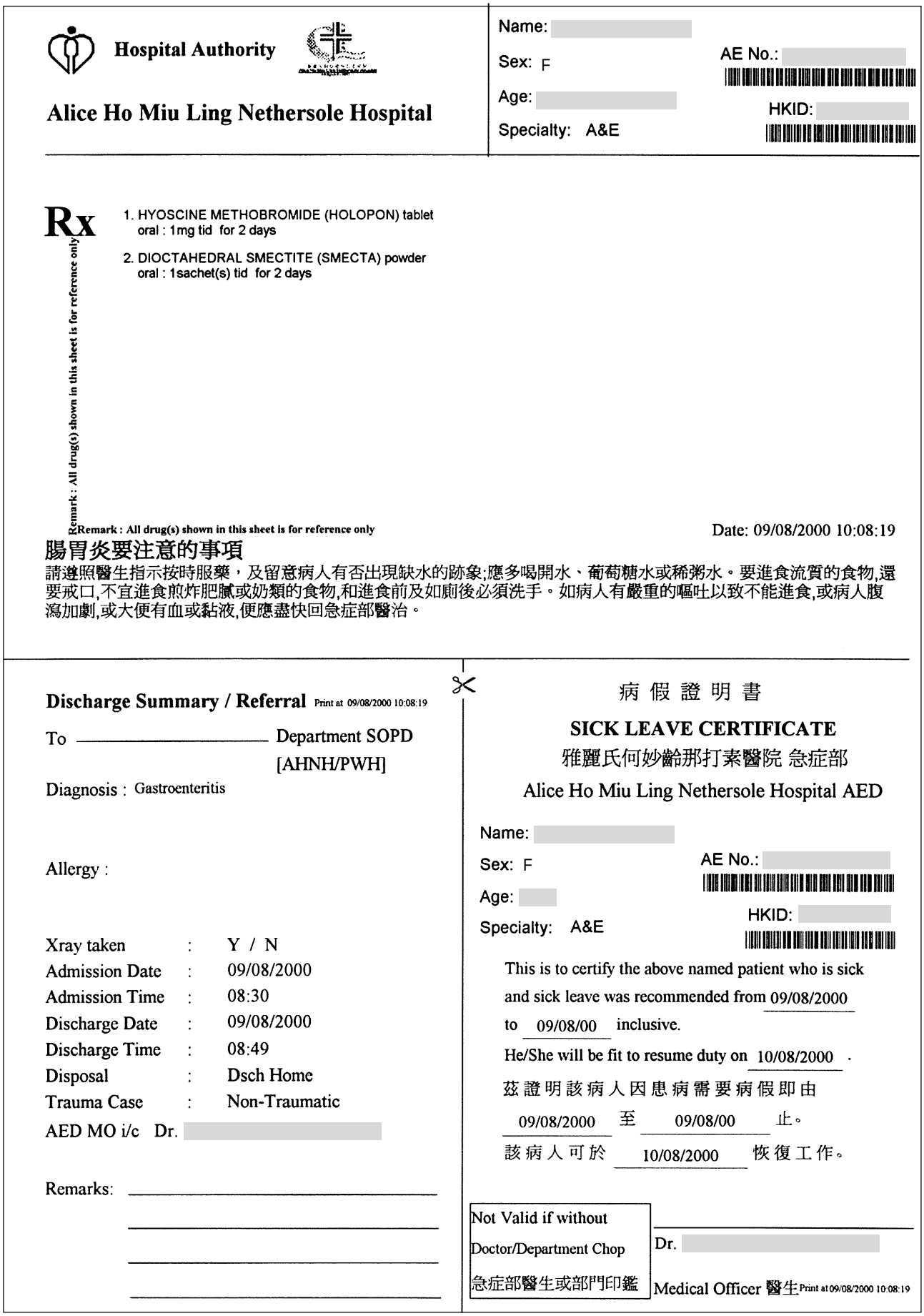
Internet instant message systems such as ICQ ('I seek you') are a revolutionary, user-friendly method of providing efficient and effective communication through personal computers. These systems are used for real-time written/vocal messages and file transfer. The compatibility problem is almost non-existent, because the message systems support a variety of popular Internet applications and serve as a universal platform from which various applications can be launched—for example, ICQ is compatible with both IBM-compatible or Apple Macintosh personal computers. It can also be used in a multiple-user mode, so that groups can conduct conferences or broadcast messages. Through instant message systems, messages can be sent between various A&E departments, and resources can be redistributed evenly through enhanced communications.

Information can also be collected through the A&E Intranet. Data are captured from terminals in all A&E departments and merged in the A&E Intranet server. Thus, a complete set of data can be generated through the system within a very short period of time. This technology is very useful, especially when there is a need for surveillance of a particular disease or condition.

In Hong Kong, patients may sometimes attend several A&E departments. When they are admitted to a hospital, the availability of A&E records from other hospitals is crucial for the decision-making process. As A&E records are scanned into the AEIS server, data can be retrieved in all workstations through the A&E Intranet. Another important application of the A&E Intranet is the Electrocardiogram Management System. When an electrocardiogram (ECG) is obtained, the data are uploaded to the computer server by means of a modem, which can transmit data from the ECG machine to the computer server through an ordinary telephone line. Once the data are stored in the computer server, ECG information can be retrieved by workstations throughout the intranet network.

The Accident and Emergency Clinical Management System

Information about departmental management was dealt mainly in the AEIS version 2.0, while individual patient care was managed by the A&E Clinical Management System (CMS). On 1 December 1997, the first A&E CMS was launched in the A&E Department of the Alice Ho Miu Ling Nethersole Hospital.[6] The Alice Ho Miu Ling Nethersole Hospital was a



Hospital Authority

Alice Ho Miu Ling Nethersole Hospital

Name:
Sex: F
Age:
Specialty: A&E
AE No.:
HKID:

Rx

1. HYOSCINE METHOBROMIDE (HOLOPON) tablet
   oral : 1mg tid for 2 days
2. DIOCTAHEDRAL SMECTITE (SMECTA) powder
   oral : 1sachet(s) tid for 2 days

Remark : All drug(s) shown in this sheet is for reference only

Remark : All drug(s) shown in this sheet is for reference only

Date: 09/08/2000 10:08:19

腸胃炎要注意的事項

請遵照醫生指示按時服藥，及留意病人有否出現缺水的跡象;應多喝開水、葡萄糖水或稀粥水。要進食流質的食物,還要戒口,不宜進食煎炸肥膩或奶類的食物,和進食前及如廁後必須洗手。如病人有嚴重的嘔吐以致不能進食,或病人腹瀉加劇,或大便有血或黏液,便應盡快回急症部醫治。

Discharge Summary / Referral Print at 09/08/2000 10:08:19

To _____ Department SOPD [AHNH/PWH]

Diagnosis : Gastroenteritis

Allergy :

Xray taken : Y / N
Admission Date : 09/08/2000
Admission Time : 08:30
Discharge Date : 09/08/2000
Discharge Time : 08:49
Disposal : Dsch Home
Trauma Case : Non-Traumatic
AED MO i/c Dr.

Remarks: _____

病 假 證 明 書

SICK LEAVE CERTIFICATE

雅麗氏何妙齡那打素醫院 急症部

Alice Ho Miu Ling Nethersole Hospital AED

Name:
Sex: F
Age:
Specialty: A&E
AE No.:
HKID:

This is to certify the above named patient who is sick and sick leave was recommended from 09/08/2000 to 09/08/00 inclusive.

He/She will be fit to resume duty on 10/08/2000 .

茲證明該病人因患病需要病假即由 09/08/2000 至 09/08/00 止。

該病人可於 10/08/2000 恢復工作。

Not Valid if without Doctor/Department Chop

急症部醫生或部門印鑑

Dr.

Medical Officer 醫生 Print at 09/08/2000 10:08:19

Fig. Example of a discharge summary and sick-leave certificate

500-bed acute general hospital with a daily A&E attendance of approximately 400. Since the A&E CMS shares the same platform with the CMS of other specialties, the A&E CMS not only allows the retrieval of A&E data, but also that of discharge summaries, diagnoses, and drug treatments from other specialties. Radiology and laboratory results are also available. The system will be extended to other A&E departments in Hong Kong later this year.

When a patient is discharged, emergency physicians will record the following data in the A&E CMS: the diagnosis according to the International Classification of Diseases version 9 with clinical modification,[8] patient alert, drugs given on discharge, and discharge information. Because the A&E CMS is linked to the hospital pharmacy's standard drug database, only available drugs can be prescribed. This arrangement bypasses to need for the pharmacy to make a telephone call about the unavailability of certain drugs or unusual prescriptions. After confirming the drug list on the A&E CMS computer screen, the physician transmits the medication order to the pharmacy electronically. All drugs are dispensed before the patient's arrival, thereby saving queuing time. Before the patient is discharged, a discharge summary and a sick-leave certificate (Fig) are printed out by the computer on the same document. The discharge summary includes the patient's demographic data, diagnosis, drugs given on discharge, discharge information, and appropriate discharges advice. The discharge advice is useful for both the patient and the physician who conducts the follow-up.

On the Hospital Authority health information superhighway, important clinical information such as the discharge summary, diagnosis, discharge medication, medical history, allergies, and laboratory, radiological, and electrocardiography results can be easily retrieved in any hospital within minutes.[9] In the A&E department, the availability of previous clinical information will be of great help to emergency physicians in the delivery of quality care to patients. Patient confidentiality is protected by the system's security check: each member staff is assigned with a log-in identity and password.

The future of computerisation of accident and emergency departments

Since 1991, Hong Kong A&E departments started to become computerised, the computer market in Hong Kong has developed rapidly, and Internet technology has become widely available. The attendance at A&E departments and the average waiting time of all A&E departments can now be viewed on a single computer screen. Furthermore, all disaster or accident groups in Hong Kong can be viewed with a specific date range.

With the help of the A&E Intranet, patient care can be enhanced because of the availability of A&E records in any clinical workstation in any public hospital. Information collection such as disease surveillance can be done in a short period of time, and disasters can be managed and coordinated efficiently and effectively. In the future, information such as average waiting times at all A&E departments could be released to the public through the Internet, and patients could go to the A&E department that has the shortest waiting time, thereby sharing the workload among various A&E departments.

Hospital managements want to resolve the problems associated with filing medical records, improve the quality and coherence of the care process, automate guidelines and the care-pathway to assist clinical research, and improve outcome management. In the near future, the main emphasis will be on electronic patient records, electronic order entries for laboratory and diagnostic radiology tests, and the development of critical pathways for particular groups of patients against an agreed clinical protocol. New technologies such as mobile workstations using wireless LAN or hand-held computers will be incorporated as tools to enhance data capture. Image transferral of computed tomograms, ultrasonograms, and magnetic resonance images will be incorporated into the system through networked graphic communication protocols such as picture archiving and communication systems. Input devices such as voice recognition, writing pads, and touch screens will also be important areas of development. Furthermore, telemedicine will be more widely used, and the concept of 'tele-ambulances' will be explored to improve the quality of prehospital care.

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