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Medical Information System in Japan: 
History, Present Situation and Future Perspective 
for its Development (***)

I am very honored to have this opportunity to report on development of medical information systems using telecommunications in Japan, especially on the roles that the Kanto Teishin Hospital has played in this development, at this Symposium sponsored by the Italian science academy.

I have been involved with the development of the Kanto Teishin Hospital for more than 30 years. In particular, for the 11 years before I retired from office as president last spring, I carefully studied the roles which our hospital, as NTT’s central hospital, should perform for further development of medical service in Japan, and have actually been able to put the results of such study into practice.

Dr. Sartori, Vice President of CSELT (Centro Studi e Laboratori Telecomunicazioni), who is a member of the Organizing Committee for this Symposium, visited Japan in 1981 and observed various systems at our hospital.

In May 1982, when the first meeting of this Symposium was held, we sent a paper on our medical information system to the Symposium, since our schedule did not allow us to accept their kind invitation to speak at that meeting.

I would, therefore, like to take this opportunity to speak about the information system designed to support medical services and to enhance their effectiveness, as well as about the concept that the Kanto Teishin Hospital relied on to develop this system. (Table 1).

If you have any questions concerning the details of the system or its future possibilities, Dr. Miyake, who is my co-speaker today, will be glad to answer

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TABLE 1 - History of the development and utilization of the Hospital Information System in the Kanto Teishin Hospital (KTH).

(1) **Total Hospital Information System.**

1966: Commencement of data communication by NTT in Japan.
1967: Commencement of preliminary research on formation of computer support of hospital health care and administrative functions in KTH.
1972: Commencement of operation of the Total Hospital Information System using an in-house computer system.
1975: Installation of a larger in-house computer system for KTH. Commencement of design of a shared hospital information data communication system.
1976: Commencement of experiments on an on-line medical practice support system called OCS (Medical Order Communication System).
1978: Start of operational service of the shared hospital information data communication system (SHIS), which initially supported only hospital business office functions.
1979: Introduction and start of operation of DUCom, which partially supported hospital administration, business office and OSC functions.
1981: Commencement of on-line transmission of clinical laboratory data through DUCom to the in-patients wards of KTH.
1982: Commencement of a nursing information system for inpatients.
1983: Start of new SHIS design work, that used new technologies.
1985: Start of changeover to the new SHIS. Beginning of design work on a new OCS as a shared-type program in KTH.
1987: Scheduled switchover of the KTH system to the new SHIS, after completion of OCS design. (DUCom and the new SHIS will be joined as one system).

(2) **Laboratory Information System « LIS ».

1972: Replacement of the laboratory computer, and enlarged processing of data, several multi-channel automatic biochemical analyzers connected to the computer.
1976: Introduction of hematological automatic analyzer and connection to the laboratory computer.
1979: Laboratory Information System started to offer the data processing service to all clinical laboratories, namely bio-chemistry, hematology, bacteriology, cytology, surgical pathology and physiology.
1981: LIS connected on-line to the DUCom center computer and real-time data providing service to the KTH wards was started.
TABLE 2 - History of development and operation of bio-physical data transmission systems and various medical information processing systems in the Kanto Teishin Hospital.

(1) **Bio-physical data telephone-line transmission system.**

1970: Single-channel ECG telephone-line transmission device developed by NTT.

1972: Long-distance (500 km) remote control of X-ray fluoroscopy through a telephone-line, with television for telediagnosis successfully performed from KTH to Aomori Teishin Hospital by NTT.

1973: Medical consultation experiments using cable television through NTT public communication network.

Experiment on medical information (including X-ray photograph) transmission using Group I (analog) facsimile.

1974: Completion of telephone transmission device for heart and pulmonary sounds.

1976: Completion of three channel ECG transmission device. Completion of cardiac pacemaker function remote check system, and clinical use started by Cardio-vascular clinic of KTH.

1978: Completion of perinatal baby tele-monitoring system.

1979: Completion of artificial heart-valve function remote check system, and start of practical use from 200 km-2000 km distant patient homes to KTH.

1980: Easy-to-use perinatal baby tele-monitoring device for use by mothers started on experimental base.


(2) **Medical information processing system.**

1973: Start of the clinical laboratory data quality control system.

1974: Start of medical records transaction system.

1976: Completion of dental X-ray film (Chephalogram) data analysis support system.

1977: Completion of the medical data I/O terminal for DUCOM.

1978: Completion of a Moare topography stereo-analysis system.

1981: Completion of a simulation program for the starting time of urinary dialysis.

1982: Completion of a stereotactic X-ray photograph analysis system for the cranial nerve-block procedure.

Completion of a drug concentration simulation system for anti-convaluent medication therapy.

1984: Completion of a vector ECG stereo-view analysis system. Start of development on the medical consultation system (DOCTORS) using artificial intelligence and a knowledge base under joint work by the Communication-Information Processing Laboratory of NTT and doctors of different specialties in KTH.

1985: Start of design work on a regional medical information communication system by Video Response System of NTT (VRS) in KTH.
them. Dr. Miyake is now playing a major role in the development of NTT's medical system, and is also involved in various projects organized by the Japanese government.

2. Administrative philosophy for development of a Medical Information System

Let me begin with an analysis of the demands for a Medical Information System from the standpoint of hospital administration.

1) Development of the Hospital Information System at the Kanto Teishin Hospital (Fig. 1)

A hospital is composed of many departments, such as medical treatment, nursing and clerical departments, each having its own function, but yet being closely connected. It will, therefore, make small contribution to the improvement of the overall function of a hospital, if the functions of only one department are upgraded. Hospital administrators must understand all the functions of a hospital in its totality and know how closely connected to each other they are (Fig. 2).
First of all, all patients visiting a hospital should be registered completely. For proper understanding of medical records, all data concerning patients of a hospital, such as the names of the doctor and nurse in charge, the patient's symptoms, and results of clinical tests and treatments carried out accordingly, should be recorded under the patient's identification number. To be more specific, the patient registration, medical record, clinical test items (e.g., X-ray test, ultrasonographic test, CT test, endoscopy, histopathological examination) and their data, as well as the records of medicines administered, operations performed and post-operative treatment, are all important.

Gathering all these data will enable you to obtain a general view of the hospital functions and to point out problems that exist. The statistical data concerning medical functions of a hospital should be collected from this point of view.

In our hospital, clinical laboratories are centralized and automated. The many and varied data produced effusively through our well-organized system are automatically sorted by computer and given to the doctor who ordered the tests. Bulk data produced in the hospital are sorted by computer according to the various purposes of their use, such as medical fee calculation, billing to health insurance organizations and drug inventory control. These data are transmitted online to the appropriate terminals, thus saving a lot of complicated clerical work. These clinical data are also sent to the centralized medical record office, where they are kept and analyzed statistically and etiologically.

The system to transmit and receive data on-line is also used for administration of medicines, and is used for reception of test data on patients held in ICU or those with serious diseases in case of emergency. It can be said that a hospital functions the way it should only when all such necessary data are collected.
In other words, if various kinds of data were gathered on-line through a communication network and a computer system, it would not only increase the efficiency of medical activities, but also bring about various other advantages. That is, they could also be used for various purposes, including hospital administration, such as medical expense calculation, streamlining of drug inventory control and optimum manning of medical staff, in addition to increased quality control of the laboratory data and correct evaluation of medical services. The following are some advantageous examples of hospital computerization:

1) Rapid increase in laboratory data (Fig. 3).
2) Better statistics on medical services (Table 3).
3) Drug inventory control.
4) Calculation of the amount of medical work and its standardization.

A hospital information system having these functions would be limited as to where it could be established, since it is highly sophisticated and large-scale.

2) **Requirements for formation of a Hospital Information System**

1) In order to accurately send and receive a large amount of sophisticated information, such data should be handled directly by the staff members (e.g., doctors, nurses, medical technologists and pharmacists in charge). They should communicate directly with the computer from the places where they are carrying out their duties. Also, such information should be used directly for medical activities, such as diagnosis and treatment. In particular, there must be considerable advantages for doctors and nurses who offer services concerning delicate human lives, to operate terminals in order to obtain their cooperation in introducing this system. As I mentioned before, it will be a significant advantage for doctors to be able to retrieve laboratory data at any time in the wards. The big advantage for nurses would be that they could collect data from any sections without actually going to that section. On the other hand, if extra staff is required for introduction of the hospital information system, it may result in deterioration of the data accuracy and also increase personnel expenses leading to a failure of hospital accounts.

2) One important point that should not be overlooked in forming a total hospital information system in a hospital is that such a system enables us to use today’s medical results for tomorrow’s activities (Table 3).

For example, if the data on individuals are placed in a time series, such data can be utilized for tomorrow’s health instruction. Group data can be utilized to make statistics on all medical services offered (e.g., clinical statistics, analysis of major causes of diseases). Also, it would be splendid to receive clinical data instantly just by operating terminals and provide appropriate treatment in case of a sudden change in the patient’s condition.

The software thus created will contribute to the continuance of high quality medical services to be offered, and to the promotion of optimal medical practice, life-time education of medical staff, including doctors, and clinical research.
activities. To attain these objectives, the following 5 plans were carried out and, as stated previously (Table 4). The structure of the Hospital Information System at the Kanto Teishin Hospital is described in Fig. 4. As was mentioned earlier, an efficient hospital system can be realized only through the integration of numerous individual computer systems. The required structure relationship among these individual systems is easily understood from Fig. 4-4 & b. Fig. 4-a shows the hospital computer utilization structure, which spreads gradually downward in the shape of a pyramid. Fig. 4-b, on the other hand, relates to the development and operation of the various systems and shows the concepts and interrelation involved.
Table 3 - Analgetic effect of gasserian ganglion block.

<table>
<thead>
<tr>
<th>Intensity of anesthesia</th>
<th>Hypesthesia</th>
<th>Affected branches partly anesthetized</th>
<th>Affected branches totally anesthetized</th>
<th>All branches anesthetized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average duration of effect</td>
<td>11 months</td>
<td>32 months</td>
<td>56 months</td>
<td>No recurrence</td>
</tr>
<tr>
<td>No. of cases</td>
<td>31</td>
<td>36</td>
<td>85</td>
<td>80</td>
</tr>
</tbody>
</table>

Reference Table. Analgetic effect of branch block on trigeminal neuralgia

<table>
<thead>
<tr>
<th>Branch</th>
<th>Supraorbital</th>
<th>Infraorbital</th>
<th>Maxillary</th>
<th>Mandibular</th>
</tr>
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<tbody>
<tr>
<td>Average duration of effect</td>
<td>15.5 months</td>
<td>14.0 months</td>
<td>13.8 months</td>
<td>18.8 months</td>
</tr>
<tr>
<td>No. of cases</td>
<td>184</td>
<td>1176</td>
<td>135</td>
<td>770</td>
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3) Development of such a large-scale information processing system, which handles compound data and requires on-line real time processing functions, is costly, but many hospitals require the use of such high-grade hospital information system as ours. So, the plan to develop the Kanto Teishin Hospital system (DUCOM) as the base for a Shared-type Hospital Information System (SHIS) in Japan was made in 1975.

We estimated the total development cost of the system to be more than 5 billion yen (20 million dollars). In comparison, the development cost of the Technicon Medical Information System (T-MIS) in the USA, which was developed at El Camino Hospital and is now being used by about 20 hospitals, including

Table 4 - Objects, plans and effects of Hospital Administration.

**Objects:**

1. Better Medical Care for Patients
2. Promotion of Post-Graduate Education
3. Promotion of Clinical Research

**Plans & Effects:**

1. Unification of Patients’ Registration . . . . Permanent Identification Number
2. Centralization of Patient Medical Records . Clinical Statistics
3. Centralization of Clinical Laboratories . . . . Key data of the Data-Base
4. Drug Inventory Control . . . . . . . . Cost Saving
5. Demand for Health Insurance . . . . Accounting Business Reduction
the NIH Clinical Center, was 20 million dollars when its development was completed in 1975.

In 1979, this service started because the basic design concept was recognized, and the number of hospitals using the SHIS in Japan has actually increased since then. Presently, 76 hospitals are using this system (Fig. 5). The number of visitors to the Kanto Teishin Hospital where this system was developed, is more than 1,000 people from 200 hospitals in Japan. We also receive visitors from Asia, Europe, and North and South America.

The design of the new SHIS started in 1983, due to progress in computer manufacturing technology and in software, providing the possibility of reducing current cost by more than half. The Kanto Teishin Hospital has decided to use this new system and has started to design a new medical service support system to be used with this new SHIS.

3) Future prospects for the Shared-type Hospital Information System

The Shared-type Hospital Information System has been brought to the threshold of greater public utilization in cooperation with MEDIS-DC (Medical
Information System Development Center, Foundation) and NTT, as well as under the guidance of the Ministry of Health and Welfare. However, further development of the system will continuously be necessary to incorporate the latest technologies into the system. Presently, a new service has started to be offered as a distributed system. The new Shared Hospital Information System service regularly provides information necessary for medical billing, which is nationally common, and processing programs common to every hospital from NTT’s computer center. Such information is received by a super-mini-computer at the hospital and hospital data are processed in unified form throughout the country. These in-hospital computers are connected to NTT’s computer center in Tokyo through a communication network. The system is always under remote monitor by NTT’s computer center to avoid any malfunction.

![Diagram of Hospital Information System](image)

- **DUCOM**: Denko Kensa Computer Utility for Comprehensive Medical Systems
- **B.O.S.**: Business Office System
- **O.C.S.**: Medical Order Communication System
- **C.I.S.**: Clinical Information System
- **DEMONS-E**: Denko Kochi Multi-access On-line System-Extended
- **L.I.S.**: Laboratory Information System

**Fig. 4b - Functional Concept for Computerization of the Kanto Teishin Hospital.**

But, in many hospitals, usage of this system is now limited to calculation of medical fees, and does not include the total hospital information services being carried out in the Kanto Teishin Hospital, as I explained before. The problems to be solved concerning the Shared-type Hospital Information...
System, from the hardware aspect, include improvement of the man-machine interface, development of a thinner CRT display unit, utilization of Kana (Japanese alphabet) and Kanji (Chinese characters) necessary for Japanese wordprocessing, display of graphs often used in the medical field, and adoption of interactive processing technology using voice. In light of the progress made in computer technologies in Japan, however, it seems to us that it will only be a matter of time before these problems are solved. It can be presumed that the roles of the hospital medical services will change significantly as they will become part of the community medical service system. However, I am confident that the fundamental functions of the hospital medical services will not change.
Table 3 - Overview of development and practical use of medical information transmission and processing system in Japan in 1985.

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<th>A. Public telephone line utilization.</th>
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<td>(1) Practical use of ECG computer analysis through public telephone lines mainly supported by regional medical associations, and several commercial centers. (In early 1984, 33 centers served 1800 clinics in Japan).</td>
</tr>
<tr>
<td>(2) Regional Ambulatory Care Information Systems mainly supported by NTT. (27/32).</td>
</tr>
<tr>
<td>(3) MEDLINE and DIALOG medical references retrieval systems served by governmental and commercial bases.</td>
</tr>
<tr>
<td>(4) Experimental supply of medical information through CAPTAIN (Character and Pattern Telephone Access Information Network) started by a commercial information provider called AMS.</td>
</tr>
<tr>
<td>(5) Vocal cord disease screening system by telephone line is being developed in Yokohama Municipal Cancer Center.</td>
</tr>
<tr>
<td>(6) Drug Information Service with combination of telephone access and retrieval. Optical laser disk and facsimile under experimental use by Japan Pharmaceutical Information Center.</td>
</tr>
<tr>
<td>(7) Start of development of a medical consultation system (DOCTORS) using artificial intelligence and a knowledge base under joint work of Communication-Information Processing Laboratory of NTT and doctors of different specialties in KTH.</td>
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<th>B. Wide-range telecommunication line utilization.</th>
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<tr>
<td>(8) In-house cable television network (LAN) working in Kitasato University Hospital.</td>
</tr>
<tr>
<td>(9) Start of design work on a regional medical information communication system by Video Response System of NTT (VRS) in KTH.</td>
</tr>
<tr>
<td>(10) Clinical Medical Practice Information Support System (electronic medical record system; medical image processing; medical consultation system by artificial intelligence) being developed by Medical Information Systems Development Center Foundation under the support of the Ministry of Health and Welfare and the Ministry of International Trade and Industry.</td>
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<th>C. Information processing and related utilization.</th>
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<tr>
<td>(11) Computer usage for medical business processing reaches more than 50% in hospitals and 10% in clinics by the end of 1983.</td>
</tr>
<tr>
<td>(12) Shared Hospital Information System (SHIS) used by 70 hospitals in Japan.</td>
</tr>
<tr>
<td>(13) Regional health care now supported by 80 Automated Multiphasic Health Testing and Service and Short Stay Human Dock Health Check Systems in 377 of the hospitals in the Japan Hospital Association. In 1984, 489,053 people were tested using AMHTS and 183,117 were tested using SSSDHC.</td>
</tr>
<tr>
<td>(14) Personal Health Administration system by IC card started by Tokyo Women's Medical College Hospital.</td>
</tr>
<tr>
<td>(15) Personal Health Data Cassette System being developed as a project under support of the Science and Technology Agency.</td>
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<th>D. Future ISDN utilization projects.</th>
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<tr>
<td>(16) Telecommunication systems for the elderly, disabled and handicapped study by the Ministry of Posts and Telecommunications.</td>
</tr>
<tr>
<td>(17) Home Health Care System and Devices by telecommunications study, also by the Ministry of Posts and Telecommunications.</td>
</tr>
<tr>
<td>(18) Teleopia regional plan promotion by the Ministry of Posts and Telecommunications and local governments.</td>
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3. Development of a Processing System for Medical Information Transmission

I would, next, like to briefly describe the transmission system for medical information that connects the hospital and the community. There are a variety of systems at present: some are actually being used, some are not yet actually being used although the experimental phase has been completed, some are under experiment for actual use, some are under experiment for development, and some are being studied for experimental development.

I would like to introduce the development research at the Kanto Teishin Hospital (Please refer to Table 2).

For information concerning the systems being used now and those under development research and experiment in Japan, please refer to Table 3. System design concepts and details of the systems will be reported by Dr. Miyake, if necessary.

4. Future Movements of Medical Services in Japan

Medical service in Japan made rapid progress during the 40 years after World War II. I have been in active service in the field of clinical medical services for 50 years and have seen rapid changes. Although I admit that there was support from the economic growth in Japan, I believe that such rapid progress of the medical information system at the Kanto Teishin Hospital has resulted primarily from the close cooperation between medical leaders, individual doctors and system specialists.

Japan is now enjoying the longest average longevity in the world. Of course, its medical facilities have been increasing; however, recently the Japanese government has adopted a policy to restrain medical expenses.

Therefore, the tasks which the present hospital medical services in Japan face, are how to promote the medical information system in order to effectively use limited medical resources, and the elimination of differences in levels of medical services among communities, as well as formation of a medical service system to cope with the future graying society.

As Italy is known to be a country with advanced medical services, I would appreciate any comments, suggestions and questions from you now.