GENERAL GUIDELINES FOR COMPUTERIZED MEDICAL INFORMATION SYSTEM ON PATIENT CARE: EXAMPLES OF SOME STATE AND UNIVERSITY HOSPITALS IN TURKEY

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ABSTRACT

Computerized Hospital Management Information Systems that have been in use in Turkey contain information on all patients admitted to inpatient or outpatient units of the hospitals. Among the data are the routine demographic information, history of prior therapy, illness history, physical examination findings, laboratory results such as hematology and clinical chemistry, serology, virology, bacteriology, immunology, urine analysis, parasitology, blood gas analysis data, and the reports of anatomical and surgical pathology, roentgen, ultrasonagraphy, tomography, endoscopy, bronchoscopy, EEG, and surgery, patient discharge summaries and billing charges.

Key Words: Hospital Information System, Computerized Medical Records

INTRODUCTION

Computerized Hospital Management Information Systems have been in use for several years (1-39) There have been several attempts to computerize the hospital management information systems in state and university hospitals in Turkey (21-25). However, there have been failures and success stories and it is the purpose of this paper to report only the successful ones in big state and university hospitals and system analysis of the patient care system which is used in almost all the state and university hospitals in Turkey.

There have been several international applications in order to build up this system in Turkey without prior knowledge of how the system works in the state and university hospitals, therefore, most of the foreign originated applications failed to be implemented and did not work according to the rules and regulations in these hospitals. First, we will give some information on some university and state hospitals that have been using computers.

In 1986, Marmara University Hospital, in Istanbul, was the first to successfully computerize and has become a successful model for computerization of the university hospitals in Turkey. Currently the hospital information system has been developed in-house and running on IBM RISC/6000 AIX system with 70 terminals (21-22).

In İzmir, Ege University Medical Faculty Hospital which has a capacity of 2000 beds is one of the oldest to computerize and currently running on IBM 3090 mainframe computer with more than 120 terminals throughout the hospital.

Dokuz Eylül University Medical Faculty, in İzmir, a 800-bed hospital has been computerized since 1989 and using unix mini computers and developed their application in-house. They have more than 80 terminals scattered throughout the hospital.

Akdeniz University Medical Faculty, in Antalya, a 250-bed hospital also developed its hospital information system in-house and has more than 50 terminals connected to unix machine.

Uludağ University Medical Faculty, in Bursa, a 1500-bed hospital has unix machines of DEC and HP and currently using a commercial Hospital Information System. They have more than 120 terminals running in the hospital.

Gazi University Medical Faculty Hospital, in Ankara, is also using this system for some of its departments,

such as stock control, scheduling of special examinations and operations etc. They are trying to add more modules to the already computerized system.

One of the biggest state hospitals in Turkey, a 2000-bed Ankara Numune Hospital has recently acquired personal computers that are connected to each other through Novell Network and is only trying to capture charges, patient tracking, and take care of the billing of the patients. It has about 25 PC's already connected to the system.

The same thing is true for another big state hospital in Istanbul, a 2000-bed Haydarpaşa Numune Hospital. It has about 40 personal computers connected to each other through Novell Network. This system is used for patient tracking, charge capture and billing. It has one network for outpatients and one network for inpatients.

Haseki Institute of Cardiology is a 100-bed specialized cardiology hospital and has 24 personal computers with Novell Network. This also provides support for hospital accounting, pharmacy, etc.

Şişli Etfal State Hospital, in Istanbul, is a 1300-bed hospital and has IBM RISC/6000 AIX system with 80 terminals and is adding new terminals to the system in order to use the hospital information system to its full capacity. This system is used for, outpatient and inpatient tracking, laboratory information, radiology information, pharmacy, scheduling of operations stock control, admission/discharge/and transfer, charge capture and billing, statistics, emergency care, etc.

Aydın State Hospital, in Aydın, is a 400-bed state hospital and it has the same system as Şişli Etfal State Hospital with 50 terminals. Currently the same functions, as Şişli Etfal are in use.

Istanbul University Cerrahpaşa Medical Faculty is a 2000-bed hospital also has Novell Network that consists of 50 personal computers and it is used for, patient tracking, charge capture and patient billing.

İstanbul University İstanbul Faculty of Medicine Hospital is a 3000-bed hospital and a manual reporting technique similar to the other university hospitals has been in use throughout the hospital. There is a very successful Central Data Processing department in the hospital which is responsible for inpatient registration and keeping the statistical data. This department is also providing services to the other clinics for billing of their outpatients and inpatients and keeping the record of payments of these bills. Large wolumes of data are genetared daily from hospital activities such as outpatient attendance, inpatient admission rocedures, patient

billing, laboratory sent to the other institutions. There were several attempts to computerize management information systems in some of the clinics in the hospital in the past. However, except pathology, microbiology, cardiology, radiology and nucleer medicine departments and pharmacy, there is no successful full computerization of management information system in any of the clinics in the hospital.

Pediatric clinic of the same hospital is a 250-bed clinic. It has a system which is connected to its subspecialty clinics within itself. Therefore, it can be considered as a separate 250-bed hospital within a three thousand bed hospital. Since it is a model for the rest of the clinics in the hospital, computerization of this clinic has been accomplished with IBM RISC/6000 AIX machines with 85 terminals. It is considered as a model for computerization of the other clinics management information systems in Istanbul University Istanbul Medical Faculty Hospital.

The Patient Care System of the Marmara University Hospital, Istanbul University Istanbul Medical Facuty Hospital and Şişli and Aydın State Hospitals were implemented by the same group. Patient care rules and regulations and guidelines are the same in all state and university hospitals in the country. Once the procedures are studied in detail in one big state and university hospital it is easy to understand how the other state and university hospitals function.

PATIENT CARE SYSTEM

The core of the information system developed at the university and state hospitals is a central data structure and a means for communication between the different systems in the hospital. The patient is accepted and registered to the system through the outpatient or inpatient admission, transfer and discharge functions of the main program and leaves the system, at least partially, through this main system. Some functions such as writing and reporting patient discharge summaries, laboratory result reports are given directly from the main computer and reports of other departments are distributed through the different personal computer systems in the clinics. Central registration, charging and ordering principles are kept in the main system to achieve the necessary integration and distribution of information to the various points like; pharmacy, billing, admission and discharge, general ledger, stock control, statistics, accounting, purchase and personel management, or in the field of care provision such as providing information on-line through the terminals located in the outpatient examination rooms, wards, pharmacy, operating theaters, ICU, central laboratories, nurse stations etc. This central data base is serving the

central operational purposes of the clinic in the context of its dual goals. The data base structures are either straight forward such as drug prescriptions, laboratory test requests and test results, patient charges, admission and discharge information, patient demographic data, or more complex in a data bank, such as computer aided diagnoses or coding of diseases of patients, results of the detailed examinations in several units such as pediatric cardiology, because of the various requirements and access procedures. Also a chronological hierarchy is developed in regard to mass storage concerning archivation of data, abstracting and maintaining central summaries of certain reports such as patient discharge summaries for long term bases.

The patient flow in hospitals and management of this function by the module is described below. This is at the same time the established patient care system in most of the state and university hospitals in Turkey.

OUTPATIENT CLINICS

Registration is the process of collecting basic patient data such as name, address, sex, marital status, place and date of birth, parents' names, social-security-number, retirement-pension-number, referring physician and institute name and address, blood type, home and business addresses and telephone numbers etc.

A special code is generated by the computer from the first three characters of patients' first and last names, patient's sex, parents' names, and license plate city code number of birth place and date of birth. A patient identification search is performed using this code to determine if the patient has had a previous encounter with the hospital.

If the patient is a recurring patient or a guarantor (parents of a newborn baby) for another patient, the existing information may be updated. If it is the patient's first admission to the hospital, the information is collected and stored in the database. A phonetic or "sounds like" name search is also performed by the computer when the special code misses to identify the patient for the previous encounters to the hospital. The purpose of this computer search is to find and display a list of all persons with similar sounds of first and last names. Sometimes either on purpose or by mistake a patient may give false information especially about his/her parents' names or place or date of birth. It has also been noted that the first three characters of the patients' names are recorded correctly and the rest of them may be misspelled or typed wrong. Therefore, the phonetic search requires only the first three characters of the patient's first and last names. Additional information

such as the sex, place and date of birth have also effects on this phonetic search.

The admission process creates a patient hospital identification number which is at the same time patient's account number, which collects additional information. Types of admission include: preadmit, inpatient, newborn patient, single visit outpatient, recurring outpatient, emergency and institutional.

Preadmit/Information Desk gives the patient a special form to fill out the required fields, such as name, last name, sex, parents' names, place and date of birth, home and business addresses and phone numbers, social-security-number if available, referring institute name and address if patient is a No-Pay patient, referring institute voucher date and number etc. and checks the accuracy of the information filled out by the patient.

Newborn admission processing is used to admit a baby born in the hospital. Babies born outside the hospital are normally admitted through regular inpatient or outpatient admission. The mother's patient identification number and her voucher from her institute if she is a No-Pay patient are required to admit a newborn for billing purposes.

There is also an after office hour admission which is called emergency admission. Emergency admission processing allows the hospital to quickly collect the minimum amount of information required to register and admit an emergency patient.

If the patient is admitted when the system is down, a downtime admission is performed after the system becomes functional.

Admission notices are printed at several locations such as the admission office, outpatient clinics admission-defined areas, archives and medical records area and the notices are put into the patient folder and the folders are sent to the appropriate clinics or outpatient clinics.

Outpatient clinics treat patients at the request of referring physician if the patient is No-Pay patient and has been seen by another doctor at his/her institute or at a the state hospital as required by law. Outpatient clinics also perform complete physical examinations for the check-ups required for the employment applications for registration to the universities, and evaluates patients for admission to the inpatient clinics.

1. The information about the patient is entered into the computer and the patient is sent to the appropriate outpatient clinic from the Registration/Admission.

2. If the examining physician recommends inpatient treatment he fills out the Inpatient Admittance Form and checks if there is a bed available at the appropriate inpatient clinic.

3. After examination and treatment the No-Pay outpatient returns to the registration to submit his report for the approval and to get it stamped and signed so that he can return it to his institute and to get the prescription filled in the pharmacy that has a contract with his institute.

4. The registration collects all the No-Pay patients' vouchers each day; at end of each day they send the no-pay patient voucher and reports to the Circulating Capital to process billing to the patients institution.

5. The procedure to get a health report for employment applications is slightly different. The applicant reports to the Health Committee of the hospital for the physical examination. Upon reporting to the Health Committee: If the applicant is referred by a government health institution he is treated as a no-pay patient, then he is not required to pay for the examination.

If the applicant does not have a government health insurance, then he is required to pay for the examination, therefore he is sent to the Cashier to pay the appropriate amount.

After registering the applicant to the system, a special form is generated from the computer and given to the patient. The patient is then routed through as many outpatient clinics as required by the company requesting the total health examination. In each clinic, the examining physician records his findings on the form. Upon completion of all examinations, the patient applies to the Health Committee office and submits the form containing all the physicians' reports. The Health Committee reviews the reports and instructs a clerk to type a report to the requesting company.

If the report is positive, in other words if the patient is healthy, the applicant may pick up the report from the hospital on the following day to be delivered to the requesting company. If the report is negative (patient is not healthy or is handicapped), then the patient is interviewed by the Committee of Health and report is written. In addition, a cover letter is completed and the report and cover letter are sent to the Document Control for mailing. When the Document Control receives the report and th cover letter, they assign a control number to one copy of the cover letter and return the cover letter to the Health Committee. All reports are either mailed to the requesting company or given to the patient. A copy of the reports is retained for ten years.

ADMISSION/DISCHARGE/TRANSFER SYSTEM

The admission, discharge and transfer system provides entry and exit points for patients and determines their location within the system.

Main functions are;
to examine, whether the patient has already been in the hospital and to assure a unique identification number that enables record linkage,
to initialize the data parts necessary for the various functions and, if necessary, departmental systems and administrative structures, and
to produce forms necessary to process admission discharge procedures.

PATIENT TRACKING

This module is responsible for directing the patient to the appropriate clinic within the hospital.

1. The No-Pay patient presents a form from the referring physician requesting examination and treatment of the patient.

2. Pay Patient (i.e. a patient who will pay his own hospital expenses) pays the examination fee. A receipt is generated from the computer and is given to the patient. The amount paid is automatically credited to his account.

3. Both No-Pay and Pay-Patients are registered to the computer and sent to the outpatient clinic. During the process of registration a charge for the clinical examination of the patient is automatically made to the patient's account. Thus eliminating the loss of income due to missing of recording of charges to the patients' accounts. Information about the outpatient clinic and doctor is entered into the computer and the related statistics is updated.

4. If the patient is to be admitted to the hospital, the patient is sent to the Circulating Capital Inpatient Admisson/Discharge Department with a special Inpatient Admission Form filled by the physician.

5. If the patient is a Pay-Patient he is asked to pay a deposit, especially if the patient asks for a special treatment such as surgery to be done by senior staff or to stay in the suit.

INPATIENT ADMISSIONS

This module is responsible for processing inpatients into the hospital and preparing inpatient information.

1. Admittance reviews documentation from outpatient clinics and prepares basic inpatient information.

a. Admittance receives doctor's request for hospitalization of the patient and patient's folder and enters the necessary information into the computer to prepare the Inpatient File to be put into the patient folder.

b. The folder and patient are sent to the Inpatient clinics secretary and the clinic chief nurse for the acceptance of the patient to the clinic.

INPATIENT CLINICS

Bed Control and Census
Bed control modules support the transfer of the patients within the hospital, the discharge of patients from the hospital and the maintenance of patient condition, service and accommodation type. No-Pay patients are given beds according to the accommodation type allowed by his official seniority in the government office. In addition, clinic-secretary may indicate when a bed is cleaned and available.

Any time census inquiry functions display the current rooms in the clinics and bed usage and availability for nursing stations special wards and ICU etc. Additional displays include a list of patients assigned to a room/bed, clinic or an individual doctor, and a list of status changes of the patients, transfers etc.

The bed control and census modules:
Bed Control;
Depending on the bed control module selected, screens are displayed to identifiy a patient, nursing station or emergency location, ICU etc. A patient can be identified by first and last name search, patient hospital identification number or location, or nursing station. This information is printed out at 10 a.m. and 3 p.m. every day for the diet/food department.

Transfer and swap patients;
Transfer processing takes place at the nursing stations by the nurses or the medical secretaries and they update information in the computer regarding the transfer of a patient from one section to another section.

Transfer inpatient: records the transfer of an inpatient from one bed to another. The transfer can be within a nursing station or to another nursing station. The patient is identified from the transferring nursing station census.

Swap inpatients: records the exchange of beds between two inpatients in the computer. The swap can be within a nursing station or between two nursing stations.

Emergency transfer to inpatient: records the transfer of an emergency patient to an inpatient nursing station. The admission information can be changed or additional information can be added.

Maintain patient's ward/room/bed number and maintain inpatient leave of absence; This module allows the hospital to indicate that a patient is absent or on leave of absence. This module is also used to cancel the pass or leave of absence when the patient returns to the hospital.

Ward (nursing station) medical secretary schedules and cancels future discharge according to the information given to her by the physician in charge of the patient.

Discharge patients;
Discharge processing collects information including final diagnosis, diagnosis related group and diagnosis code, discharging doctor, date and time of discharge and discharge status, surgery (if performed) explanation and its outcome, recommendations made to the patient, drugs to be used or treatment to be continued and the patient discharge summary.

Readmit patient discharged in error;
This module allows the hospital to cancel the admission in error or admission made to the wrong ward or the patient is assigned to the wrong doctor.

Maintain status of the beds;
This module allows the hospital to maintain the status of beds (occupied, unoccupied, available etc.). Nursing stations are responsible for all patient care subsequent to admission to the hospital.

1. The clinic receives the patient and the patient folder from the Circulating Capital Admission/Discharge Office.

2. During the course of treatment, patient data is continuously updated from treatment sources (i.e. pharmacy, radiology, surgical units, laboratory). All these expenses are charged to the patient's account automatically in the computer.

3. When the patient is going to be discharged the clinic secretary enters the appropriate information related to his discharge into the computer and sends the patient folder to the Circulating Capital Admission/Discharge.

4. If a patient is a No-Pay patient and had no special treatment such as surgery done by a senior staff

upon his request or stayed in the suit, the patient is discharged and the bill with the voucher is sent to the patient's employer. If he had special treatments he is required to pay these extra charges. If he is the Pay-Patient he is required to pay the bill and discharged. If the patient cannot pay his bill he is sent to the Chief Doctor for waiving of the bill or for a discount. If the Chief Doctor concurs, he signs off and the patient is sent back to the Circulating Capital Admission/Discharge.

5. From the Circulating Capital, the clinic receives information that the patient has settled his bill and the patient is given a paper generated from the computer that he is to be discharged from the hospital.

6. Exitus Discharge is responsible for completing the death certificate of a patient who died while being treated at the hospital. The patient's relative has to go through the same discharge procedure as a live patient.

Inquiry and Update;
Inquiry modules provide the display of patient information such as; biographic and demographic, employer, referring doctors, diagnosis, memos and discharge reports and recommendations, insurance and government institute or the private company he is employed by. Additional displays are; a summary of his account, charges, payments, doctors, ward/room/bed numbers occupied by the patient during the previous hospital stays, admission, transfer and discharge dates etc.

Reporting
To assist in the efficient management of the hospital census reports, daily, weekly or monthly admission activity reports, charges generated by the departments, laboratories, outpatient and inpatients seen by the doctors or the clinics, revenues generated by the departments, doctors or wards etc. are provided every month or any time requested.

The following types of reports are provided by most applications.
1. Census reports
2. Daily/weekly/monthly/quarterly/yearly admission activity reports
3. Support data base reports.

Census Reports
All census reports are generated using the summary files that are updated continuously at each transaction. The census reports are:

1. Nursing Station Census.
This report provides a list of total number of beds, occupied and vacant.

2. Inpatient Bed Census.
This provides the ward/room/bed/patients' identification numbers, names and last names and bed numbers.

The report sequence is Nursing-Station/Room/Bed/Patient Identification Number/Name/Last Name

3. Admission list.
This report provides a list of inpatients admitted between the inquired dates.

Admit/Discharge/Transfer;
Several different types of reports are generated for each service and doctor.

These types are:
Emergency room admissions
Single visit outpatient admissions
Recurring outpatient admissions
Inpatient admissions
Inpatient transfers
Planned discharges
Pass and leave of absence
Activity totals are printed at the end of each type of report. The report sequence is:
Type of the report/Name of the patient

4. Census of the doctor
This report provides a list of active inpatients assigned to each doctor.
The sequence in the report is as follows:
Ward/Doctor/Nursing—Station/Room/Bed

5. Census of the service
This report provides a census of active inpatients by medical service. Totals are printed at the end of each service. The report sequence is:
Medical service/Nursing-Station/Room/Bed

6. Beds Available by Service.
This report provides a list of available beds by medical service. The report sequence is:
Medical service/Nursing-Station.

7. Census Summary by Service.
This report gives a summary of total hospital utilization provided by medical service. Totals are printed on each report. The report sequence is:
Medical service/Nursing-Station

8. Revenues: This report provides a summary of total revenues which come in from any source.

9. Procedures performed by doctors and services: This report provides a summary of the procedures performed by doctors and the services given by the wards, patient status (Pay or No-Pay patients), sex of the patients etc.

10. Pharmacy İnformation Report: This report gives information about the drugs prescribed by the doctors in connection with day/ward/room/bed/patients/ patients' status and sex.

Support and Maintenance
Maintenance of the data base is available through on-line functions. These data bases are:

1. The Main Profile contains information which identifies the hospital and defines the tables used to validate information specific to the hospital such as doctors, services, clinics, departments, rooms/bed numbers, procedures performed, list of terminals and printers and their routing etc.

2. The Health User Profile identifies all authorized users of the systems and contains the user identification code, password and user master screen.

3. The Patient Data Base contains information about each patient or the guarantor (private company or a state institute which pays the patient's bill) registered by the hospital. The updated information used to identify a patient is controlled and audited.

4. The Third Party Data Base identifies all the third party payers and specifies detailed information about these companies, institutes or the state agencies.

5. The Nursing Station Data Base identifies and defines the inpatient nursing stations where the clinic secretaries work as the main person who enters the data in to the computer about charges, transfers or order entries.

Feature provided by the applications
Required Field Indicators:
Certain fields data are required to be entered into the system depending on the function performed: the name of the doctor, clinic or room/bed number patient is assigned to, discharge status or the length of hospital stay, patient status (Pay-Patient or No-Pay patient) etc.

Length of Editing
It is important that the information entered into the system is accurate and acceptable for further processing. For this reason, editing is performed on codes such as medical service, room and bed numbers, doctor or procedure code, diagnosis codes, dates, numbers, city licence plate code numbers, etc.

Optional Admission/ Discharge Screens
One of the good features of the HMIS is that only the screens required to collect admission or discharge information for specific circumstances of each patient are displayed for data entry. The screen flows vary

according to the type of admission and selections made by the interviewer. For example, the screens which collect special treatment such as surgery to be performed by a certain doctor upon patient's request or to stay in a special suit etc. are only displayed if the interviewer indicates that the patient wants special treatments. In case of discharge, if there is an additional discharge information about surgery, diagnosis, disease code, recommendations made to the patient etc. the relevant screens are displayed to enter the information.

Registration of the Third Party Payers
The third party payers are registered in the system and maintained in the data base like patients. While several patients may have the same third party payer. The payer data is only stored once thus improving accuracy.

Generation of Patient Hospital Identification Number/Account and Medical Record Numbers:
The Patient Hospital Identification number which is at the same time patient's account number and Medical Record Number can be either automatically assigned by the system or manually. Certain group of identifiction numbers are reserved for some group of patients such as the patients examined by the senior faculty staff in the special outpatient clinics upon patients' request paying the extra examination fee.

Security, Auditability, and Control.
Security is provided in several ways:

1. System access is limited to individuals with valid sign-on codes, identification codes and passwords.

2. The functions that a user performs are controlled by a master screen and a security level code is associated with the user's identification code.

3. Audit trail of users and functions affecting information within the system is provided. For example, any admission, discharge, transfer, order entry, expense charge or laboratory request or result can be trailed easily in the system using the security code associated with the user's identification code.

PATIENT CARE PLANNING AND SCHEDULING SYSTEMS

Scheduling systems for the transportation of patients for the various examinations and interventions such as radiology examinations, physical therapy, etc. echocardiography planning, pre-admission in some departments and outpatient scheduling and nursing care system have been developed. For example; as

for the pharmacy, a sorted report about the day total of each drug ordered, total number of drugs in the wards, patients' hospital identification numbers, names and last names etc. can be obtained at any time. The same thing is true for radiology, and special departments such as ECG, central laboratory, and nursing. Due to lack of sufficient number of terminals provided to the nursing stations and the other departments this module except for the pharmacy is not used to full extend in the hospital.

DISCUSSION

The choice of programming "language" is extremely important. The difficulty lies in understanding the problem in the hospital and finding a logical solution. The system should be multi-user, multi-tasking and real-time, therefore, the choice of UNIX operating system is very important. The programming languages should permit the production of the code capable of creating and manipulating large and complex data files. Such file handling is the core of all applications that is concerned. UNIX offers an environment for free flow of thought and despite the ease of programming the resulting code is very efficient in disk storage and speed of data retrieval.

The local area network (LAN) system connects the departments both in patient care and hospital management and provides the means for daily operations. The MIS has a broad interface with the main data base both in regard to LAN and to data base structures. Consequently, the data exchange between these systems is high in volume and in frequency. The list of modules and functions is not exhaustive. These modules can be used or more functions can be added according to the changing demands of the hospital. One application may span different functions and vice versa the modules can be broken down to more subfunctions. According to the specific tasks of the hospital administration, these modules can be separated. At the university or state hospitals an integrated view is possible because the administrative data are derived from the medical actions. Vice versa medical actions can be reviewed and correlated to the administrative functions and consequences. Despite the difference in the nature of the financial and medical aspect of the operations a hospital tries to provide maximum service to the patient with optimal procedures thus eliminating the redundancies while maintaining high quality of medical care. The hospital LAN spans to a wide area and provides a general tool for the scheduling and processing of patient care. Most of the procedures planned or supported are able to provide basic information for cost accounting and billing. In the hospital more sophisticated approaches combine

reporting systems (like radiology, pathology, endoscopy, patient discharge summaries, surgery and anesthesia reports) with abstracting and coding for further classification or process. The same is true for surgical pathology, histopathology, dermatology, pediatry, surgery, neurology and neurosurgery patient examination reports. The departmental modules communicate broadly with central data base. Nonetheless, our own storage structures are developed for performance, safety and optimal storage. In principle, the functions described here may be implemented in separate hardware structures as it is needed provided that the software guarantees the necessary integration and communication.

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