COMPUTER PROGRAMMES IN PEDIATRICS

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It is a general feeling that computers are associated with mathematical calculations and engineering field. Since doctors have lost contact with this field long back, most are apprehensive about learning anything about computers. There is also a feeling that computer needs bright young brains and one is too old to even try to understand this new field of Medical Informatics. It is true that computer programming needs good brain, dedication and training. But just as those of us who are not mechanical engineers, drive the car without fear and get all the benefits of a car, without being an expert programmer or knowing any computer proficiently, one can still learn a few basic skills necessary to use the computer. More details about the basics of computers are reviewed elsewhere(1,2).

Having acquired these skills one becomes a "trained user" and can enter into the tremendous information explosion created by the computer in the field of Modern Medicine. There are numerous "User-Friendly" packages which give precise instructions to the user at every step bring the world of Medicine literally at your Finger tips. (using the computer key board). Computers have truely created a revolution in the field of medicine. The advances that are useful in pediatrics are briefly outlined below.

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Computer Based Examinations and Testing (CBT)

The National Board of Medical Examiners, USA pioneered the application of new testing techniques in examinations used for licensure certification and self-assessment in the health professions(3). The Module used is CBX: Patient simulator. Multiple choice questions can also be generated by a computer. Such models can prove very useful in India to ensure uniformity of assessment especially in competitive examinations where a large number of students appear.

Computer Assisted Therapy

(*i*) Computerized home telemetry for maternal blood sugar levels in diabetic pregnancy have been used in many hospitals in UK. A telephone telemetry system permits results from patients home to be monitored directly by a computer in the obstetric unit. The graphs generated are read by the physicians and telephonic advice is given to the patient. This has reduced the cost and number of visits of the mother to the hospital at the same time allowing a closer and convenient supervision of the pregnant diabetic mother(4,5).

(*ii*) Computerized treatment intervention has improved perinatal survival and care in NICU infants. Computers can precisely calculate and administer ventilatory support, drug dosage and nutritional requirement, as well as regularise incubator temperature and wean from nursery to ambivalent temperature(6,7).

(*iii*) Antibiotics in renal failure(4): In 1970 Jelliffe reported a computer programme that used a one compartment pharmacokinetic model to predict antibiotic requirement. The therapeutic doses of aminoglycosides such as gentamicin are close to toxic levels during renal failure and emperic methods of modifying the dose are inadequate.

(*iv*) Computer based cancer chemotherapy (4): ONCOSIN was first tested at an oncology clinic at Standford and deals with every aspect of managing chemotherapy in cancer. Computerized planning of radiotherapy is rapid and accurate. CT Scan of patients are used as the direct outline for treatment planning.

Computer Based Literature Searches and Data Bases

All doctors go through the harassment of searching references for their doctoral dissertation or preparing research papers for publication. Today sitting down at the nearest computer is the quickest way to sift through millions of references for the information you need to have in minutes, via the medical database–MEDLINE(8) and related databases like CANCERLIT, AIDS, *etc.*

Computer Based Clinical Data Management System

Computers are widely used in scientific research because they analyze a large number of data accurately in short span of time(9). Analysis of health records can also help to highlight particular trends which provide valuable tools in making decisions for national health policies.

Good data collection and management is fundamental to any research and statistical analysis. This assumes more significance in the medical field as major policy health decisions, management strategies and protocols of various diseases have to be based on this research.

To date the best established use of Computers in Pediatrics, has been in the perinatal and neonatal field(10-12). The use of computers in perinatal medicine has grown since early 1970. Medical record data management, fetal and neonatal monitoring and neonatal surveillance are the most common applications of computers in perinatal medicine.

By linking data from Gynecology to Obstetrics to Pediatrics, through the creation of perinatal data bases, computers enhance information flow, thus improve continuity, improve quality of care assessment, care of at risk evaluation and statistical analysis(12).

Perinatal databases may be general or specific. General data bases co-ordinate and retain all medical record data for current and future use. Specific data bases are created for a special purpose like fetal monitoring or neonatal screening and may be integrated with general data bases(11,12).

Perinatal data base management systems whether 'retrospective' or 'on-line' integrate antepartum risk assessments, laboratory results, ultrasound evaluations, with labor, delivery and neonatal data.

Perinatal data base exists at all levels of health care: Office based, clinic based,

hospital based, regional, state, national or even international, shared between a group of nations(11,13,14).

The Latin American Centre for Perinatology and human development uses a page Standardized Perinatal Clinical Record (SPCR) as a planning tool for perinatal health coverage in thirteen countries, collecting data on maternal history and risk factors, labor, delivery and neonates. Use of the same form in all participating institutions, anticipates merging data for epidemiological studies(13,14).

Needless to say, perinatal data base establishment in our country, would go a long way towards assessing the present care plans and evolve strategies for the future.

Fetal and Neonatal Monitoring

The ability of computers to capture, store and process complex signals from electronic devices makes them valuable in perinatal monitoring(7,8). Examples of computerized monitoring include; ultra sound evaluation, detection of uterine contractions from background noises, CT scanning, monitoring of fetal heart rate and respiration(15,16).

Data generated from monitor is stored electronically to generate patient specific data files. Computerized monitoring can co-ordinate the simultaneous data produced on several parameters like airway pressure and flow. It can calculate physiologically significant variable and trends such as respiratory rate(6,16). Such data facilitates clinical decision making and treatment because important clinical factors and relationships can be detected earlier. Once these data are collected and stored, computers can reconstruct events for further evaluations, improving on patient care policies(15,16).

Computer analysis reduces time involvement, observer fatigue and calculation errors because definite criteria can be applied repeatedly and persistently. Computerized monitoring thus can lead to fewer management errors during care of high risk infants. The same can also generate output for medical records, patient billing and quality of care assessment.

Computerized Neonatal Screening Surveillance

Computerized data bases in US facilitate newborn screening for Phenylketonuria, galactosemia, hypothyroidism, biotidinase deficiency and other genetic diseases by co-ordinating the activities of the practitioner, screening laboratory and follow-up team(17,18). This has distinct advantages, namely, it generates large quantities of data that require repetition and analytical calculation and linking of individual results, reports and follow up which would be difficult to manage with paper based systems.

Laboratories with unusual error rates are identifiable by data base analysis. An association between low birth weight (LBW) and high false positive rates for hypothyroidism and phenylketonuria was detected in the California Screening data base in USA(16,17). The data base provided actual T4, TSH and phenylalanine levels for the establishment of new cut-points for presumptive positives in LBW.

Hospital Information Systems

The use of computer technology can provide cost-effective monitoring of quality of care as well as meaningful improvement in outcome in big hospitals as well as Group Practice or polyclinics(19).

Advantages of automated quality control include elimination of the frustrating limitations of paper chart, such as poor accessibility, illegibility, and poor organization. This achieves cost savings in the medical records and billing departments by reducing effort spent on pulling and filing charts and reports in connection with patients' visits and billing. It gives better service to patients by providing better information availability, and more convenient appointment making and referral. This allows the doctors to do research and quality assurance studies as part of their daily practice activities using the same clinical data base which supports their practice. It allows excellent interdepartmental co-ordination, resulting in a broader impact of improved patient care and efficiency. It enhances the ability to effectively evaluate care and to expand and co-ordinate various activities productively.

Use of Computers in Improving Nursing Resources(20)

In an era or nursing shortage, it is important to maximise the time nurses spend on patient care and minimize the time spent on tasks that do not require professional nursing expertise. Well designed computer systems may increase nurses' productivity by simplifying information management tasks, that now consume a large part of their time. In recognition of this potential, there is need for computer technology to cater to programs that support nurses and other professionals in the medical field.

Computer systems that manage the flow of information between nursing units and ancillaries save time for nurses. Time savings of 15 minutes to one hour per nurse per shift were seen in most hospitals depending on the type of programme used. The savings of overtime can be translated into cost savings for the hospitals. There was a great saving in tasks that are accomplished by routine paper work or telephone on line calls. The complex system of manually maintained documents, lists and card files, that are used to keep track of orders in most hospitals make errors inevitable. There were fewer errors in carrying out orders after such programmes.

Computers in the Clinical Laboratory

Auto-analyzers of biochemical tests, *e.g.,* SMA; automated hematology; LARC (Leucocyte automatic recognition by computer); fluorescent activated cell sorting-helper and suppressor T Cells; computerized ECG, EEG and EMG have proved extremely useful.

Computerized Medical Imaging

A few examples of computers in nuclear medicine imaging include SPECT (single photon emission computed tomography); PET (positron emission tomography); CT (Computerized *X*-ray tomography); DSR (digital subtraction radiography); US (ultrasonography); and NMR (nuclear magnetic resonance imaging).

Thus skillful use of computers in all fields of medicine can build up clinical expertise which will ultimately lead to better patient care in a cost effective manner.

Artificial Intelligence (AI)

Artificial intelligence is that branch of computer science which is concerned with building systems that mimic human intelligence, largely through the use of non-numeric symbol processing. Computer

aided medical decision making are called expert systems(3). With the help of computer based advice a mediocre doctor can have at his fingertips, an expert at his beck and call as it were and produce an output of doctor with an excellent analytical mind.

Several expert systems are now available for use. The older ones are INTERNIST/CADUCEUS. The newer ones which are truly interactive are DXplain and QMR.

1. *DX Plain (Diagnosis explain):* This was developed by Dr. Barnett at the laboratory of Computer Science (LCS), a research unit of the Department of Medicine, Massachusetts General Hospital (MGH) and Harvard Medical School (HMS) and released in June 1987(21). It deals with the etiology, signs and symptoms, laboratory finding and disease courses of 2100 diseases and conditions. Using 5000 medical terms and 65000 disease–term relationships, its knowledge base is larger than what is usually contained in a medical textbook. DXplain interacts with physician accepting a list of clinical manifestations and then proposes a diagnostic hypothesis. It gives quick and easy access to comprehensive data base of signs and symptoms of different diagnosis to explain clinical features entered. It also explains and justifies its interpretation.

During my one year tenure at the Laboratory of Computer Science, I and a pediatric colleague (Mitch Feldman) added more than 25 neonatal disease description to the DXplain database and modified many diseases from pediatric base.

2. *QMR (Quick Medical Reference):* This was developed by Dr. Jack Myers and Dr. Randold Miller at the University of Pittsburgh. It is also an excellent system having a database of more than 600 diseases but it does not have a Pediatric data base.

Computers in Pediatric Education

Computer based education or instruction (CBE or CBI); also called Computer aided instruction of learning (CAI or CAL) has been well established in the medical education field in the West. Many of the average medical students would benefit from individualized learning programmes. There is always a dearth of good motivated teachers who due to various problems cannot find the time or energy to undertake individualized training programmes. CAI can provide learning opportunity in an individualized manner, allowing each student to proceed at his/her own pace giving instantaneous feedback and supervision, guidance and evaluation in a tireless manner.

A new module under trial is the CASEBOOK, currently under evaluation for Pediatric and Obstetric students at Harvard Medical School. This PC-based system is designed for medical students to create a computer based medical record on all the patients and the procedures gone and seen during their training. This data can be retrieved by faculty members to examine and grade performance. A password is provided for each student, faculty member and administrator. It generates report on the difficulties encountered by the students for the administrators, to help in improving training.

Interactive learning in simple language are computer based programs where the student interacts with the computer for the process of learning. Thus the students are no longer passive listeners but become active participants in the process of learning. There are many forms of "Interactive Learning(22).

Advanced Programs of Interactive Learning

A new and exciting form of interactive learning is "The scenario based simulations". These are based on video disc technology and are reviewed in detail elsewhere(22).

The highly visual nature of medicine and the necessity to integrate material related to anatomy, physiology, pathology, radiology and other contexts make video discs a powerful adjuvant to medical education. Video discs have excellent features like still images, freezeframes, slow motion and fast scan capabilities.

(*i*) A module on neonatal emergencies and procedures and congenital cyanotic heart diseases has been developed. In this, the students watch a baby being born and are told it is cyanotic. They are given four options. If they touch the correct one, *e.g.,* intubation: the video demonstrates the correct procedure for inserting a tube in the baby's windpipe. Next they can move the stethoscope on the babies chest; the correct area gives the heart sounds. They can next decide on management by seeing *X*-rays, blood gas studies.

(*ii*) A module on radiology teaches about recognition of artefacts on *X*-rays, *e.g.,* ingested oral objects–ring in child's stomach.

Other Forms of Interactive Learning(22)

(*i*) *Drill and Practice and Question Banks:* Some students may need many revisions to grasp a subject matter. There is often insufficient time in the classroom and such activities can bore teachers. Students response is graded and it can also be in a game format and he can complete with the computer.

(*ii*) *Tutorials:* Here principles are presented like a lecture and at the end they are queried. Depending on the response, in depth training can be given.

Clinical Case Simulations

Another very popular form of interactive learning is "Simulations". Simulated patients offer a risk-free setting to experiment with, before one comes in contact with a real life patient. The student can understand the results of wrong treatment and even result in death of the patient (only on the computer screen). Repeated interaction with the computer programs can raise the level of an average student to that of a very intelligent student who has the capacity to grasp the subject by the traditional methods without repeated sessions. Other details of simulations are discussed elsewhere(22).

In the American hospitals, the children are first seen by a Registered Nurse Practitioner. The nurses are trained to diagnose, manage and treat all common childhood problems and show to the pediatric consultant only if they feel the need to do so. Thus the programs created for nurses are good for our students, general practitioners or medical officers who have to treat children. They also can be used by pediatricians for self-assessment on common presentations like management of febrile seizures, meningitis, cerebral palsy, pneumonia, cystic fibrosis and congenital heart disease. We need to prepare programs in India based on the more common problems like diarrhea and dehydration, tuberculosis and ARI, which will have our epidemiological background and management pertaining to our set up.

Modules are available which cover common pediatric problems including

rash, diarrhea and ear infections. These are very useful in learning techniques, in diagnosing and management of frequently occurring pediatric problems. The outcome of each case is determined by description of symptoms, the users decision on diagnosis, and prescription of treatment. Users diagnostic skills are tested and critiqued with a summary for each case. Case studies include high fever and a rash; rash on back; rhinorrhea, vomiting, irritability and fever; and diarrhea.

Pediatric Nursing–Communicable Diseases in Children

Given a set of signs and symptoms, this module will enable the learner to differentiate between measles, rubella, chicken pox, scarlet fever and mumps to decide nursing interventions. The role of nurse in identification, prevention (disease and spread) and education is also highlighted. It has individual modules on each disease as well as a special module.

The clinical simulations in nursing pharmacology include:

(*i*) Immunizing children against communicable diseases (details of vaccines and parent education).

(*ii*) Management and anticipatory guidance in prevention of accidental poisoning in children, *e.g.,* iron intoxication.

(*iii*) Drug therapy for pre-schooler with asthma.

Maternal-Fetal Medicine: Computer Based Educational Series

Each program has a tutorial segment teaching one particular area of obstetrics, a tracing simulator and hands on experience with simulated patient management.

(*i*) *Fetal Monitor Interpretation:* This program is a practical and effective way to augment the knowledge gained through clinical experience and to prepare for the situations yet to come. It has four modules and allows the staff to apply knowledge by evaluating randomly generated tracings and managing realistic simulated case studies. It also teaches interpretation of fetal heart monitor.

(*ii*) *Advanced Fetal Monitor Interpretation:* This teaches fetal heart monitoring that covers basic heart patterns, fetal arrhythmias, sinusoidal and salutary patterns, variable decelerations and bradycardia, and fetal scalp blood pH sampling. It has a malpractice case which discusses the important legal aspects of the complexities of interpretation of fetal monitoring.

(*iii*) *Antepartum Fetal Assessment:* This program gives an upto date review of the most modern and effective techniques. It reviews non-stress and contraction stress test, ultrasound use in evaluation of fetal well being and bio-physical profile. It also gives training in interpretation of NST, CST and intrapartum tracing interpretations.

In the recent years, there is a tremendous market in the USA in the field of medical software. As more and more doctors are getting 'Computer Literate", companies are churning out software programmes in medicine which are really electronic books. The knowledge you can get by going to the library and referring from a book, is more readily available on the computer. It has the advantage or retrieving whatever you need in matter of seconds and give you a print out, saving the time of making laborious notes, often illegible later!

Most of these are of very high standard but like the books in the market, some are of mediocre quality. The companies generally have highly academic persons on the

editorial board. These are mainly experts in the field or Professors from Universities. They provide the data base (information in computer language) and the programming is done by expert programmers. Hence, the packages or programmes are usually of high academic content and technically superior.

If a doctor invests in a computer, such programmes are available from 150 $ onwards, and one can make a software library on medical programmes. Since this may be too costly for an individual, what we need in India is to invest on an institutional basis where a large number of individuals can make use of this technology. Most of these programmes are suitable for India. However, many would need modifications from Indian point of view in relation to our epidemiological pattern and our clinical presentations.

REFERENCES

1. Bhave SY. Introduction to basics of computers. Bombay Hosp J 1991, 33: 122-132.
2. Bhave SY. Computer language, programming and computer viruses. Bombay Hosp J 1991, 33: 130-135.
3. Lele RD. Computer assisted decision making. *In:* Computer in Medicine, 1st edn. New Delhi, Tata McGraw Hill Publishing Ltd, 1988, pp 156-158.
4. Lele RD. Computer assisted therapy. *In:* Computer in Medicine, 1st edn. New Delhi, Tata McGraw Hill Publishing Company, 1988, pp 186-190.
5. Dalton KJ, Alban Davies H, Nicholos J, *et al*. Computerized home telemetry of maternal glucose levels in diabetic pregnancy. J Perinatal Med 1987, 15: 93-97.
6. Lindstrom D, Colton R. Use of computers in Neonatal Intensive Care Unit. Clin Perinatol 1983, 10: 195-203.
7. Pelstein RH, Edward NK, Atherton HD, Hammersen MC. Computer assisted environmental control in newborns. *In:* The Use of Computers in Perinatal Medicine. Eds. Harris TK, Bhar JP. New York, Prager Publications, 1982, pp 262-373.
8. Suzan Judith M. Searching Medline. Group Practice J 1990, 4: 26-32.
9. Computer System helps analyze data on psoriasis. Skin Allergy News 1986, 17: 11.
10. Ferre C, Chandler A, Rosenberg D. Indian J Pediatr 1989, 56: 625-630.
11. Jennett RJ, Gale D, Waterkotte GW, Warford HS. A computerized perinatal data system for a region. Am J Obstet Gynecol 1978, 131: 157-161.
12. Harris TR. The use of computers in perinatal medicine. *In:* The Use of Computers in Perinatal Medicine. Eds. Harris TR, Bhar JB. New York, Prager Publications, 1982, pp 3-22.
13. Schwarcz R, Diaz AG, Pascina R, *et al*. The perinatal information system I–The Simplified Medical Record (SPCR). J Perinat Med 1987, 15 (Supp I): 9-15.
14. Simini F, Diaz AG, Lopez R, Schwarz R. The perinatal information System II–An instrument for epidemiological control. J Perinatal Med 1987, 15 (Suppl i): 131-135.
15. Bahr JP, Grausz JP. Real time analysis of patient data. *In:* The Use of Computer in Perinatal Medicine. Eds Harris JR, Bahr JP. New York, Prager Publications 1982, pp 311-326.
16. Otto WJ. The design and implementation of a computer based ultrasound data system. J Ultrasound Med 1985, 5: 15-32.
17. Meany FJ. Computerized tracking for newborn screening and follow up–A review. J Med Systems 1988, 12: 69-75.
18. King N, Nash C, Jons D. Newborn

screenings in the 80's the automation of follow up. J Med System 1988, 12: 89-96.
19. Studney DR. Monitoring quality by computers. Group Practice J 1980, 3: 10-12.
20. Hendrikson G, Kovner. Effects of computers of nursing resources use. Group Practice J 1980, 3: 15-19.
21. Barnett Dxplain. An evolving decision support system. JAMA 1987, 1: 258.
22. Bhave SY. Interactive technology in the field of medical education. Bombay Hosp J 1991, 33: (in press).

INTRAOSSEOUS INFUSION

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In critically ill children rapid establishment of an intravenous (IV) access is vital. However, efforts at setting up an IV line in a peripheral vein may fail in 5-6% or get delayed beyond 5 minutes in about one-fourth to one third of such children(1,2). Intraosseous (IO) access may be of value in such circumstances as an alternative route for delivery of fluid and medication. Use of this route was first proposed in 1922(3,4), and gained rapid acceptance for routine infusion of saline, glucose and blood by 1940s and 1950s(5,6). However, with the advent of better IV technique it was relegated to relative obscurity despite the fact that the ease and simplicity of technique would appear to make it ideal for use in emergency situation. The technique is now experiencing a resurgence(7). Recent reports and reviews suggest its use in pediatric emergency situation such as cardio-respiratory arrest, shock, *etc.* when IV access is difficult(8-10). The American Heart Association in its Life Support Course recommends use of IO route when IV access can not be readily established(11).

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Anatomical Basis

Basically IO infusion is intravenous infusion through rich network of venous sinusoids of medullary cavity of the bone. The network is supported by a bony matrix and therefore, does not collapse even in shock. The venous sinusoids drain into the venous canal and then through nutrient and emissary veins into systemic circulation. Thus, substances infused in the bone marrow are almost immediately absorbed into the circulation.

Technique

The actual technique is simple and easily mastered and has been reviewed recently(9,12). All it requires is a needle with a stylet which is sturdy enough to penetrate the bony cortex. Although many specialized needles have been developed for this procedure the standard bone marrow needles or heavier gauge (14-18 size) spinal needles are good enough. The most preferred site is on the flat anteromedial surface of proximal tibia, 1-2 cm below the tibial tubercle. Other sites are distal tibia and distal femur (*Fig.*). Detailed steps in setting an IO infusion are as follows: After restraining the leg, skin is cleansed with an antiseptic (spirit and iodine/betadine) and local anesthesia is administered. The needle is inserted perpendicularly to the