

Computer Technology and the Surgeon: What the Resident needs to know

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ABSTRACT

Background: Computer technology is now a well established resource in medicine and medical sciences. Surgery in developed countries has taken great advantage of this resource. This review is intended to highlight important aspects of computers in surgery and also encourages surgeons in Nigeria to acquaint themselves with its influences.

Methods: Publications from local and international journals as well as standard surgical texts were reviewed.

Results: The role of computers in surgery spans the areas of patient care, training, research, communication as well as surgical administration. Though a compliment to the surgeon, it has its problems including overwhelming information requiring careful scrutiny; computer fraud, hacking and viruses; copyright laws; the 'threat' of a well-informed patient population; and the risk of over dependence. Surgery in Nigeria and most of African is yet to maximize its benefits.

Conclusion: The application of computers in surgery will in the near future make surgical knowledge and practice become more simplified and less time with increased productivity will be required even for highly technical procedures.

KEYWORDS: Computer; Surgeon; Resident.

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INTRODUCTION

A computer is an electronic device that stores information on discs or magnetic tapes, analyses it and produces it as required from the data on the tapes¹. Since its invention by *aficionados*, to ease the tedium of mathematical and scientific calculations, it has undergone tremendous development over time².

The vast influence of computer on human life has reached a scale beyond earlier imaginations. Its goals in the field of surgery are facilitation of activities, enabling cumbersome and impossible procedures to be performed e.g. cardiac surgery and vascular surgery, and re-engineering of teaching and research³. Surgery also benefits from its digital tools- word processing, data analysis, record keeping and the use of the Internet.

The resident needs to appraise this rapidly expanding technology in order to keep pace with the ever-

increasing advancement in medical science.

ROLE OF COMPUTERS IN SURGERY PATIENT CARE

The computer can be applied in the diagnosis, treatment/monitoring and follow up of patients as follows:

Diagnosis

Medicine is rapidly becoming evidence-based. Clinical features can be fed into a computer, which produces a series of differential diagnosis in order of likelihood with significant accuracy. Such diagnosis entails enormous amount of work and has been confined to remote outstations such as submarines, spacecrafts and for specific interest research groups^{4,5}.

Most investigative equipments e.g. digital X-ray, ultra sound scan (USS), computerized axial tomography (CAT), magnetic resonance imaging (MRI) and electrocardiography (ECG), now have digital outputs that could be readily accessed from consoles located in any part of a hospital that has been networked^{2,3}. Certain equipments have become miniaturized by this technology ultra sound scan, electrocardiography such that they form part of bedside or intraoperative diagnostic tools. Newer applications such as computerized axial tomography (CAT), and ultra sound scan (USS), are gradually complementing endoscopic retrograde cholangiopancreatography (ERCP)^{6,7}.

Treatment

Computer technology has also revolutionised surgical treatment through the application of its technology to improving the tools and techniques of surgical procedures.

Virtual Reality

This has, via visual enhancement afforded by stereotactic rendition of the operation field, made significant impact in the rapidly expanding field of endoscopy. Incorporation of virtual reality into difficult training circumstances such as neuro-surgery and cardiac surgery, by provision of simulated scenarios, improved cost effective planning and training⁸. It also has many applications in teaching laparoscopic

procedures such as appendectomy, cholecystectomy etc.

Robotics

A robot is a computer controlled mechanical system with anthropometric (human-like) characteristics⁹. The potential benefits of the robotic technology have now been turned to surgical practice. Most of them are extenders of the human arm with vast manipulative capabilities that can be utilized to facilitate, but not take over the many functions of the human hand. Zeus^R and da Vinci^R are two of such systems licensed by the Food and Drug Agency (FDA) in the United States of America¹⁰.

Robots have the following valuable areas of interest in surgery:

Augmentation of surgeon's arm by providing a 'third arm' that can be voice controlled, thus, hold and manipulate instruments e.g. Endoscopes¹¹.

Enhanced dexterity: the robotic hand, though lacking the human hand's great range of motion, is more precise with superior consistency in procedures where repeated precision is needed e.g. in spinal canal surgery and modeling bone planes for orthopaedic prosthesis insertion¹². This helps dampen tremors, an unnecessary side effect of ageing among surgeons.

Nano-technology: is the field of computer that entails the application of small robots (incorporating advanced microchips and battery) for working in remote terrain. Modeled and swallowed as capsule, it has been used as gastrointestinal endoscopes at a British laboratory where it sent pulses of clear pictures as it migrated down the intestinal tract¹³. It has been envisaged that this can be used in the near future to invade specific areas of the body and target diseased tissues, deliver cytotoxic agents to tumour bed, and unclog cerebral vessels of blood clots at a cerebrovascular accident site.

Improved ergonomics: the computer allows the surgeon to sit comfortably at a control panel, while using virtual reality, manipulate robotic controls to handle instruments and successfully conduct delicate operations such as coronary bypass, cholecystectomy, endoscopic hernia repair etc¹⁴.

Image guided positioning: stereotaxis, through simulation in training of surgeons as well as in surgical planning, has enhanced success and safety of many surgical procedures. Image guided fine needle aspiration biopsy (FNAB) of small lumps (e.g. mammographically detected breast lump), is now more precise and simpler². Endovascular ablation of Berry aneurysm is demonstrably possible with robotic

tracking and guidance².

Elimination of hazard: the robotic arm can safely place therapeutic radioactive rods in body tissues and cavities, removing the surgical team from hazardous irradiation and caustic chemicals².

Telemedicine

This involves the instantaneous, two-way transmission of digitally encrypted medical data over telephone lines to vast distances across the globe. It has allowed surgeons bridge distance barriers to perform various tasks by remotely controlled robotic tools. Surgeons can interactively take part in surgeries done at different corners of the world without being physically present¹⁵. Teleconferences, exchange of texts, pictures, voice and video data is also possible. This may help address the shortage of specialized manpower in resource poor countries.

Others appliances

The integration of laser technology into intraoperative histopathology allows instantaneous interpretation of biopsy specimens without recourse to frozen-sections². Though experimental at present, it will be highly welcomed by surgeons especially in the field of oncology.

Newer generations of anaesthetic monitors now have integrated computer programs such that they become programmable and with digital data storage capabilities. The data could be replayed for teaching, post-mortem case analysis and research. This concept has been applied to ECG machine, blood gases monitor, anaesthetic gas machine, temperature and pH probes and biochemistry monitors have all been adapted to this concept.

A patient's scanned image can be computer sculptured by his plastic surgeon, creating an array of possible body image modifications from which the prospective patient can choose¹⁶. Laser keratoplasty allows ophthalmologists to remould the cornea in order to improve vision without the use of external lenses¹⁷. Optometry has also been rendered more exacting through the application of digital technology. Increasing use of voice activated display units will free the hands for other use and increase resource utilization within the operating suite¹⁸.

TRAINING

Computer technology has revolutionised the acquisition of knowledge, which has hitherto been tedious and hampered by distance. Educational application of this technology is not restricted to

residents but also applies to practicing physicians, medical students, other hospital staff and patients as well. Virtual reality packages have reduced the tedious hours spent in the formalin fumes of medical school dissection rooms¹⁹.

Surgical and other texts come in user friendly CD-rom, or could be copied onto diskettes; complete with video clips. Huge volumes of books and other materials can be conveniently carried and replayed for the trainees benefit. Digital camera has, by way of digital photography, decentralized medical illustration from the hospital-based units and is only limited by the surgeon's imagination, and is much more cost effective¹⁹.

Data on all aspect of surgery can be readily accessed on the web. Interactive sites, online journals and abstracts are available free from useful search engines such as Medline, Pubmed, HINARI etc⁴. Generation of materials for public presentation has never been much easier with better quality than now. Whatever the format; be it on paper, 'screen show' on a computer terminal, overhead projection (Power Point) or on photographic slide; it can be generated at a computer using graphic programme³. Pictorial, classic graphs or text can be included with the advantage of freely changing fonts, character size and orientation. Materials from scanners and other devices like the mouse and drawing tablet can be imported and incorporated.

RESEARCH

Research planning, data collection, collation and analysis are now mostly computer based. Laboratory tools have been reengineered into digital format enabling easy data collection and recording onto preset computers. Data analysis is more feasible using computer software like Epi-info, Statistical Package for Scientific and Social Studies (SPSS), and Jandit^{3,4}. Illustration facilities for graphs and histograms can be produced using specific software such as Lotus123 and Harvard graphics⁴.

Medical search engines like WebMD, Pubmed, Medline etc have made literature search, access to online journal articles and electronic ordering commonplace.

The stored data can be updated and retrieved at will for analysis. Papers for publication and research abstract prepared for scientific meeting may all be produced using the computer. Collaborative research efforts are much easier with improved e-mail communication. Curriculum vitae (CV) can also be prepared, updated, and reproduced on computer for application for research grants.

COMMUNICATION

Computer technology has significantly improved the communication network of the surgeon and magnified the scope of his social and professional interaction through the use of digital telephone, laptop, palm top and pager. Internet access and e-mail facilities help him download vast information on diverse topics at minimum cost. Reference materials can readily be consulted by the bedside or at clinic.

Networking has facilitated accessibility of data to all, and permitted input from distributed sources³. Patients' records (including clinical summaries, demographic data and laboratory and radiological reports) can be available whenever and wherever needed. All these without the need of physically producing and distributing paper copy.

SURGICAL ADMINISTRATION

Word processing has revolutionised administrative paper work. Digital and recallable formats have replaced the traditional way of preparing documents and can be corrected without the need of retyping altogether.

Hospital record keeping has become more efficient while tracking; updating and retrieval systems have been simplified. Vast records: case summary, laboratory or operation reports together with radiological images, consultation letters can be written and scanned onto compact discs for permanent storage. Booking admissions and planning operation list have become much easier with this technology.

Online referrals can be done and necessary files can be downloaded with the referring doctor's permission and the patient's approved consent, thus shortening referral time with less cost²⁰. A curriculum vitae can readily be kept, modified as necessary and readily reproduced for application for jobs, grants, annual hospital administrative filing, annual research progress etc.

The introduction of accounting packages allowing the linkage of payment points to a central unit has streamlined hospital accounting.

PROBLEMS/DISADVANTAGES AND SOLUTIONS

Despite the above-mentioned contributions of computer technology to the field of surgery, it has its problems and unresolved issues. These include:

Robots are still merely human extenders because they cannot make the judgment required of a surgeon. As medical knowledge is rapidly expanding, the explosive information on the computer can be overwhelming. The surgeon therefore needs to sift the

grains from the chaff in order to maximize the accruing benefits for his chosen application of this technology¹⁸.

Computer fraud has assumed a dimension requiring a global cooperative effort in order to keep it to a minimum. Patient's confidentiality cannot be assured over the Internet, and can be breeched. Computer hackers and the ever-present danger of the rapidly spreading computer viruses are other important problems. These necessitate frequent backup of stored data either as printed hard copy, floppy diskettes, zip drives, compact disks, flash disks or uploading onto free Internet storage spaces. Copyright laws need to be appreciated and respected before the use of information obtained from the Internet..

As the general population becomes more informed through the information it accesses over the Internet, the surgeon will frequently be asked challenging questions and litigations may increase. He should be prepared to answer these questions truthfully and also needs to keep abreast of the rapidly changing trend in his field. International legal bodies need to iron out an appropriate legal framework to address legal implications of online referrals, treatment via telemedicine, surgical decision following videoconferences etc.

Computer technology seems to over-simplify everything with the tendency of producing less experienced surgeons that may be too lazy and take things for granted. The ultimate use of this technology should be to increase productivity in a manner that is so intriguing that the wish to reduce a day's work and have more leisure time is subverted³.

IMPLICATIONS FOR AFRICA

Most of Africa is yet to reap the maximum benefits of this technology. Some of the perceived causes of this lapse include cost constraints, erratic power supply, poor pay checks that cannot purchase the needed updates and subscriptions, poor telephone services, wrong government priorities, corruption, and the many political and social conflicts ravaging the sub region²¹.

Surgeons in the region need to keep abreast of the trends in computer technology and its application to their field. Motivation, awareness and regular access to this technology need to be emphasized. Computer education should be an integral part of medical school curricula, and all faculty members should invest judiciously in its cost effective application to enhance their productivity. The surgeons, as a vanguard group, need to influence public leaders towards judicious investments in this technology that may yet bridge the poverty gap between the western world and ours.

CONCLUSION

With advances in technology, it is hoped that in the near future, surgery will be made much more simplified; highly technical procedures will be made easier; and that less time, with increased productivity, will be required in these activities. It must be appreciated that the computer is not a substitute for clinical experience, acumen or expertise but just a compliment.

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