Tele-Education – Postgraduate Education

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Key Words

Tele-education · Telemedicine

Abstract

Telemedicine was originally developed by the space agencies for the health care of astronauts and since that time it has become a useful tool for the care of populations remote from sophisticated medical centres and more recently for those who merely live outside hospital and often reasonably close. The use of video conferencing in medical education has grown progressively over the years and this application has now nearly outstripped its clinical use. There are several uses in postgraduate education and one of the most important is continuing medical education (CME). This allows the best of educational programmes to be delivered using knowledge from anywhere in a country or overseas and delivering it directly to the doctor's office if necessary by means of a bridge which allows simultaneous interactive teaching at up to 32 different sites. It is also possible to teach practical manoeuvres by means of video conferencing. As part of a CME programme, seminars from colleges and lectures from key figures in a speciality can be delivered to a lecture room at the other side of the world without loss of quality and with full interactive capability. Equally, it is possible to deliver a paper at a conference in

another country and take part in the discussion or attend a conference or the part one is interested in without leaving the place of work. A further recent innovation was the demonstration of the feasibility of supervising research work in another country and even of examining the report or thesis for a higher degree from two sites. All these applications can result in considerable cost savings and make it possible to greatly improve interchange of knowledge across national or continental boundaries. They can obviate the problems of relocation of whole families in an alien climate or culture. In some cases, however, travel to another city or country is of value, and it may be best to have a flexible system where travel is still possible in addition to electronic transfer. It is also important to choose the best equipment for the applications intended. This implies compatibility with equipment in the centres to which connections are to be made and the presence of a good after-sales service from the supplier. A good central system is needed to deliver conference or lecture material to peripheral sites. It can be complemented by much less expensive PC-based equipment for individual reception and discussion. For research supervision, a PC-based system with internet connection and a document camera would be ideal. Availability of ISDN lines in the region of setup should be of prime consideration. Even though dedicated lines in countries where domestic communication is cheap and

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will be heavily used is reasonable, but where international communication is envisaged such a system may be very expensive. If ISDN telephone lines are used for communication, it will also be necessary to determine how many lines to use simultaneously to achieve the necessary quality of picture. Much consideration should be given to this aspect. Satellite communication for video conferencing is also possible and will be economically feasible in the coming years.

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Introduction

Telemedicine was initially envisaged as a means of improving health care in a remote situation and as such it was originally designed and promoted by the space agencies. The technology spilled into the civilian sector following the placement of a man on the moon, and indeed one of the first trials was of equipment put together by NASA into a caravan which moved about rural Arizona helping a nurse to look after remote Indian reservations by bringing the nurse and her patient into audio-visual communication with a district hospital. Subsequently, its value in education was realised and the use of video conferencing is now regarded as being equally as important in education as in medical practice. A very early experimental application in education in fact took place shortly after the establishment of the telstar satellite in space. This was envisaged as a means of speeding up the availability of medical research information by beaming it direct to various international centres as it was in progress. This was in 1961. A group of medical scientists spoke and transmitted research experiments in progress from studios in London and Glasgow to the Academy of Medical Sciences in New York while a group of American scientists transmitted to an audience in the Royal College of Surgeons in London. This was an impressive performance which took place in elapsed time, but the bit which was lacking was the possibility of interaction and that is essential for good teaching.

Video recordings have been used in education for many years now and have provided great improvements in communication, but it is still not possible to provide interaction between the author and the class. Video conferencing, however, provides virtual reality in seminar teaching since it is possible for the teacher to have the names of the class in advance, to have eye contact and to ask questions directly. The teacher can also gauge the mood of the class as though he were in the same room

though he may be on the other side of the world. He can thus adjust his delivery to the mood of the class. Equally, the class can ask direct questions of the teacher and engage in direct conversation. It is difficult to appreciate just how effective this form of teaching is unless it is experienced. This is true interaction.

Video conferencing is the part of telemedicine which is used in postgraduate education. The internet is also not only in the process of revolutionising the way medical practice is carried out but it is also used in telemedicine and medical education. There are several distinct aspects of postgraduate education in which video conferencing can have an impact and each of these will be considered. Each of these will best be served by different types of equipment and at different running cost. Aside from the equipment used, however, there are many distinct ways of connecting the site delivering the teaching with the site receiving it.

Methods of Connecting Sites

Integrated System Digital Network (ISDN) Lines

There are video conferencing units available which function on a plain old telephone system. They are very slow and the quality is very poor compared to that which can be obtained using ISDN lines. ISDN lines are telephone lines which carry digital signals and each ISDN line has two channels, each of which is capable of transmitting information at 64 kilobits per second (kbps); 64 kbps is sufficient for good audio transmission, but it is necessary to use two such channels together to provide sufficient bandwidth for an acceptable motion picture to be produced in addition. Thus one ISDN line contains two channels, each of which is equivalent to one telephone line and one ISDN line transmits information at 128 kbps. One ISDN line will produce blurred pictures if the conference participants move much, but it is acceptable for discussion from one site to another provided the operator and participants have had some training and practice. Good motion picture quality can be obtained, however, by using three ISDN lines which provide a speed of transmission of 384 kbps. This gives particularly good quality if equipment is used which can transmit at a speed of 30 frames per second. The running cost of using a system based on ISDN lines can be accurately determined since it is a little more than the cost of a telephone call between the two sites, but the cost will, of course, depend upon the number of lines used. Thus, when using one ISDN line, the running cost will be the cost of two telephone calls (one for each channel) for the time spent and when using three ISDN lines, the cost will be that of six telephone calls for that time. ISDN lines provide an excellent and cost-effective means of video conferencing and they suit all tele-educational applications. The running costs are directly proportional to the time during which the system is in use.

Dedicated Connection

Where there is no digital telephone exchange, transmissions can be made by a dedicated line. Such lines often use fibre optics and the quality of the resulting imagery can be very good indeed. Such a sys-

tem is, however, very expensive to run since the line is continuously active whether it is in use or not. A main advantage of using ISDN lines over a dedicated line is that you only pay for the time the system is actually in use. For most applications, and particularly for tele-education, the cost renders the use of a dedicated line unacceptable.

Direct Satellite Connections

A further system which can be used where there is no suitable telephone exchange or dedicated line available is by using an equipment which accesses a satellite directly. This unit consists of a small box with a dish antenna which is pointed at the satellite directly and to which is connected the video conferencing equipment. This system is costly to run but is useful, particularly when ISDN lines are not available. It is also useful for remote or rural areas where telecom infrastructure is minimal. This system was used by journalists during the war with Iraq because all they had to do wherever they were was place the unit on the ground, point it at the satellite, and transmit high-quality audio-visual images.

Local Area Network (LAN) Connection

This refers to the use of the type of communications network, which is often found nowadays in large modern buildings such as universities and hospitals. There are devices available which can be attached to such a network of video conferencing so that video conferencing is available wherever there is a LAN connection. This provides greater flexibility and convenience for use since it is not necessary to move equipment into the rooms only where ISDN lines have been installed. The quality is also good since the bandwidth available is in the range of 10 mbps compared to the 64 kbps of ISDN channels.

Video Conferencing Systems

Having chosen the means of connecting the sites to each other, the next important step is to choose a video conferencing system that will suit the applications envisaged for it. There are three main types of equipment in general use for video conferencing: group system video conferencing, the desktop video conferencing system and a custom-made system.

Group Systems

A group system is dedicated machine used entirely for video conferencing at high resolution and with 30 frames per second quality. The heart of every system is the coder/decoder (Codec). The Codec transforms the analogue signal from the video camera to a digital signal and compresses it for transmission to a distant site along telephone lines. At the distant site, another Codec transforms the digital system back to an analogue signal for viewing on the video monitor. Some Codecs allow users to simultaneously work on creating documents, annotating them or even drawing on them or on photographic images as they discuss a subject or case at different sites.

Additional features accompanying the Codec in a system such as this are a camera which can be controlled by both the local and remote sites, power microphone, speakers and video display units. High-quality sound is vitally important and minor fluctuations in the quality of the images can be accepted provided the sound is of the highest quality. Additional equipment that can augment the system are a laser printer, a facsimile machine, a document camera and a video recorder. The document camera is of much value in rapidly transmitting and annotating large paper documents such as graphs and other diagrams together with X-ray images.

Desktop Systems

Desktop units are systems which allow video conferencing between two sites using a personal computer. For video conferencing there are add-on boards which fit into standard expansion slots in the PC together with software and a video camera. It has not been easy to use desktop products for telemedicine applications. Among the challenges are limitations of the available products, a shaky video quality, poor network integration and lack of interoperability. Despite these drawbacks, these systems are popular among doctors. This is because even though the picture quality can be poor, there are numerous other advantages, such as the facility for maintaining patient records and easy access to the internet. These systems are also very useful for one-to-one teaching, such as research supervision, and there are now desktop systems which can transfer information at 384 kbps and these provide fairly good image quality.

Custom-Designed Units

These systems take account of the particular requirements of a system and the needs of the environment where it is installed. All the equipment and peripherals are installed in one rack, bearing in mind the ease with which it will be used. There may well be problems in using such a system for other purposes, however.

Uses of Video Conferencing in Postgraduate Education

Continuing Medical Education

CME has become increasingly important for doctors during the past decade and with the growing requirement for continuous improvement of quality in medical practice, it is now virtually mandatory in well-organised systems of medicine. While many nations have laid down

standards for CME, there is a growing surge of opinion that such schemes should be internationally standardised and interchangeable. As efforts are directed towards determining the most effective method of CME, there is general agreement that some form of small group teaching fulfils the criteria most effectively. This fits in well with the concept of making use of telemedicine or video conferencing in this area since relatively simple equipment can be used to receive teaching from a centre even in the doctor's office. Such classes are usually quite small and it is possible by means of a bridge to speak to several sites at the same time and remain interactive.

When it comes to the choice of the transmission medium, however, the question of quality arises and associated with that is expense. One-to-one teaching can be achieved satisfactorily using one ISDN line (128 kbps) and the transmission of various images may be good enough using that same medium, but it does depend on the message the teacher is trying to impart. A quick look at a grossly abnormal X-ray by means of a document camera may be quite adequate during a clinical demonstration to a postgraduate class of general practitioners, but it would not be good enough for a class of trainee radiologists. Equally, the transmission of, say, post-mortem findings would be hopelessly inadequate using one ISDN line, and three ISDN lines or six channels (384 kbps) would be needed to provide adequate tissue definition [1, 2]. The choice of the number of lines which provide adequate definition for various applications is, of course, bound up with cost, since the cost of transmission is related to the number of channels in use. Once again, this may not be too much of a problem where the teaching centre is within the same town or even country as the peripheral stations, but when the teaching material is being provided from an overseas location, costs will be greatly increased when more than one ISDN line is in use.

Video conferencing calls can be made at reasonable cost between countries where there is a digital telephone exchange, but while high-quality calls can readily be made between any two places in the world, the local time may provide a limiting factor. The distance between the main centres of Europe and the Middle East for example is such that sessions delivered in the morning from Europe can be received in the afternoon in the Middle East. The distance between the USA and the Middle East, however, is such that one party must transmit or receive during the night. This becomes progressively worse the further the American centre lies towards the Western seaboard. On the other hand, there is little difference in the call charges between the USA or Europe and the Middle East.

Research Supervision

Research training requires supervision and certain research requires specialised laboratories and special supervisors. Supervision of research from a distance has been evaluated over recent years between Aberdeen University, UK, and the UAE University using video conferencing, and several postgraduate students have now achieved MScs and PhDs by this means. The minimum time to be spent on site is specified by most universities and this amounts to about 6 months over 3 or 4 years. The balance of the time can be spent in the student's own country working on a project of value to his own country and related to his work interest. The manner in which this has most commonly been achieved is for a concentrated initial phase of teaching to be carried out in the host country during which the project is designed and basic research methods are taught. The student then returns to his home country to collect his data and has a weekly or monthly video conference with his supervisor because there will be problems as there are with all research projects. They often return for a second session to base where detailed instruction can be given on analysis and presentation and the student then returns home to complete the thesis. This process has worked well in the UAE/Aberdeen experiment and 6 students have graduated with MScs and 3 with PhDs.

A very successful initial stage of this approach was carried out some years ago between Kuwait and Aberdeen, UK, when a series of MSc projects were supervised by Aberdeen University in continuous quality improvement in health care [3]. At that time video conferencing was not available in Kuwait and the supervisors visited Kuwait once per term to sort out the problems, but it was frequently noted that the whole process would have been very much more efficient if a video conferencing system had been present for periodic consultant and day-to-day answers to specific problems as they arose. A further problem during this episode of research training was difficulty in obtaining literature in Kuwait, but this has now been overcome by the international availability of Medline and the internet.

As the process has developed, it has become possible to deliver research method seminars from a distance as classroom teaching, but actual research supervision is usually carried out on a one-to-one basis. The most useful equipment for this purpose is probably a desktop system with the addition of e-mail, internet access and a document camera. This provides the means to answer questions on specific problems to discuss progress and also transmit large documents as e-mail attachments. Thus, a

very comprehensive system of supervision can be set up by the combined use of video conferencing and e-mail and internet access. The combined use of these aids provides excellent supervision and together they are much more powerful than one component acting on its own.

When it comes to the examination, this can also be conducted very effectively by video conferencing with the external examiner in one country and the internal examiner in the other or indeed both examiners at a different site from the student. This has been achieved now by several universities and is the norm in the UAE/Aberdeen project.

A further advantage of postgraduate research training being carried out by video conferencing and e-mail is that the student can devote himself totally to his project without the problems of living away from his home environment and the cultural shock associated with moving his family to a strange culture and environment where a different language is spoken. Equally, the students often find considerable support in their own country from colleagues who are interested in the results of their research, which will hopefully apply to the interests of their parent department and their country. As time has passed, a further experiment has been carried out to determine whether it would be possible to supervise a degree project wholly by the use of video conferencing and e-mail. This has now been achieved and the first two Aberdeen MSc projects have been successfully completed in the UAE this year by means of electronic supervision and examination.

It has seemed clear from time to time that supervision has been more effective by electronic means than by residence within the supervisor's department since regular appointments for supervisory sessions preceded by e-mail reports have to be booked in advance and do always take place. Most projects supervised thus far by electronic means have involved epidemiology rather than laboratory investigation. If a local facilitator is available in the form of a senior figure for consultation and advice, the process is more likely to be taken to a satisfactory successful conclusion.

Conferences

An important part of postgraduate development and continuing education is provided by attending conferences and reading papers to one's peers and listening to constructive criticism. This can be very expensive for universities and it is usual to limit attendance at conferences to 1 or 2 participants and to limit individuals to one or two conferences per year. Also, it is usual that the person attending is expected to read a paper or act as a session

chairman. A great deal of relevant information is thus lost to active research workers who are often junior in any case. Equally, it may be that only one or two papers are of much interest to an individual in a conference and the travelling time and expense of attending the whole conference has yielded little return for the resources expended.

It is now quite possible to transmit an entire conference to a distant lecture room and for as many people to attend for as long or short a time as is necessary. It is just as possible to read a paper from a distant site and take part in the discussion of that paper. A paper was successfully delivered from the UAE University in Al-Ain to the annual meeting of the Royal College of General Practitioners in Aberdeen in 1995. The presentation was successful even though it was only delivered by means of a PC-based instrument using one ISDN line. The discussion was adequate also and at that time the experience was gained of being part of the rest of the session by sitting in electronically. The following year a group of surgeons in Al-Ain, UAE, provided a whole session at the annual meeting of the Association of Surgeons of Great Britain and Ireland in Glasgow. They presented three complex surgical problems with the appropriate radiology and histology. In one case a colonoscopy was also successfully transmitted. Each case was followed by a discussion between the UAE surgeon and a panel of experts in Glasgow and this was followed by a free discussion between the UAE surgeons and the general audience. This was a very satisfactory session from both sides [4].

These two episodes clearly demonstrated the feasibility of presenting both research papers with appropriate audio-visual aids and clinical presentations accompanied by appropriate investigations – colonoscopy has been shown to be transmitted very well (though at least two ISDN lines are needed for adequate image quality), but other endoscopies are equally possible with appropriate peripheral attachments, e.g., ophthalmoscopy and otoscopy. It is even possible to transmit heart and breath sounds by means of an electronic stethoscope.

Although it has been demonstrated that participation at conferences in another country is perfectly possible, one disadvantage is that coffee breaks are missing. This may sound facetious, but conference organisers have learned to include fairly long coffee breaks in their programmes since it is now held by some that a very important part of the conference is the ability to have informal discussions with workers in the same field. This is an important disadvantage of video conferencing, but it merely suggests that although there are big advantages in being able to provide as much conference participation as

needed by electronic means, there is still a need to make provisions for conference attendance if the informal discussion sessions are considered to be of importance. Equally, although the ability to supervise research by electronic means makes the research experience in postgraduate training much more widely available, there are some for whom the experience of another culture provides positive educational advantages. Thus, it may also be of value to maintain the dual availability of electronic supervision alongside the possibility of living in another country for those who would benefit from it. In the Arab world, females often have difficulty in travelling unaccompanied to foreign countries for prolonged periods. Electronic project supervision would be of great value in that situation.

Training of Specialists

In providing clinical training for specialists, particularly that of the major specialties such as surgery, medicine and obstetrics, it is becoming more and more difficult to obtain good training posts in recognised overseas centres and equally, it is recognised that undergoing training in the parent country may provide better training opportunities provided adequate and experienced supervision can be made available. One answer is for alliances to be formed with existing Royal Colleges so that the trainees can have access to the expertise of experienced trainers and their assessment methods. In the clinical area also, the use of conference equipment would allow joint grand rounds to be held between participating hospitals in different countries. Not only would it be an advantage to sit in on the grand rounds of a famous centre in another country, but questions could be asked and there could be alternate clinical presentations.

Transmission of Pathology

As the basis of medicine, pathology is of fundamental importance in the practice of medicine and in medical teaching at both the undergraduate and the postgraduate levels. Histological diagnosis can be difficult since the pathologist must be able to move the slide around freely. While this is now technically possible by means of a robotic connection, it is not actually necessary in the teaching mode where a field is chosen by the distant teacher for demonstration and if he wishes to move the view, he can easily do so. Also, since the view remains stationary for some time, it is possible to obtain excellent definition using even one ISDN line. This is more difficult when it is desired to show tissues, as in post-mortem demonstrations, and particularly when it is wished to move the tissue. This is important for clinical demonstrations at both

undergraduate and postgraduate levels. It has been shown, however, that very adequate demonstrations can be achieved using three ISDN lines. If less than three lines are used, the tissues lack sufficient definition for adequate demonstration. It is also necessary for the demonstrator to have some training in telemedical presentation because unless his movements are slow and deliberate, there will be blurring with loss of definition. This is important since it is not easy to obtain post-mortem demonstrations in the Middle East for cultural reasons and they need to be obtained from overseas [5].

Practical Techniques

Continuing medical education, particularly in an area like surgery, has a strong practical component and the possibility of carrying this out at a distance needs some consideration. It has been shown, for example, by one of the authors that cardiopulmonary resuscitation can be adequately taught at a distance with the appropriate arrangement of cameras at both ends. This is an area where frequent refresher training is needed if the skill is to be maintained. The author has achieved very adequate refresher training of nurses in this area when the nurses were in hospital in another city and the teacher in his office at the university. In the matter of surgery, it seems doubtful whether conventional operative surgery can be adequately taught by this means even if the cameras can be adequately arranged for good vision. Operative surgery training requires close supervision in the training mode, which can hardly be provided unless both surgeon and trainee are in the operating theatre. This cannot be so if the operation is being supervised in space or on an Antarctic station, but such situations are hardly CME. The same is not true of minimal access surgery or endoscopic surgery where the trainee would normally be in a position to observe the procedure with modern techniques through an adjacent viewing lens. Any situation where an adjacent lens can be used is appropriate for the video conferencing approach – this of course also applies to the postgraduate training of radiologists. When it is considered that the trainee is at a stage where he can conduct the operation or the examination himself, the roles can be reversed and the trainee can be supervised from a distance.

Preparing for Clinical Examinations

Students from the university system of one country or culture often find difficulty with the examination system of another country. Currently, the Royal Colleges and other certifying bodies are located in only a few countries and

although many of these bodies are prepared to conduct examinations in host countries, they still apply the criteria of the parent country and their own culture and college. Thus, students whose postgraduate clinical training has been in their own country can find themselves at a disadvantage when they present themselves for examination. It would be possible to prepare students for examination by overseas colleges by conducting mock examinations from the colleges by video conferencing. This could well convert a disadvantage into an advantage since it would not only train the student in the examination technique, but greatly enhance his confidence when he presents himself for evaluation.

It has been demonstrated in offshore medicine in the North Sea that it is possible for a doctor to arrive at a diagnosis by observing a nurse examining an acute abdomen or the hand for tendon injuries. It is just as possible to observe the examination procedure adopted by a postgraduate student. Also, by the use of an electronic stethoscope, the examiner can listen to the same heart and breath sounds as the student and appreciate his description more readily. Equally, by using a secondary lens, the examiner can observe the fundus or the ear drum when the student uses the ophthalmoscope or the otoscope.

Thus the same equipment and techniques can be used to provide postgraduate clinical training in peripheral hospitals from a main centre in the same country or from an overseas centre of excellence. A certifying college can also assist by relaying its seminars to top up local expertise by certifying local supervisors and by practising examination techniques with postgraduate students.

Establishment of a System to Support Postgraduate Education

There will be different requirements for equipment in different countries and environments, but in a country the size of Kuwait, the best system would probably be one major central system based either in the University or the Kuwait Medical Association with a number of smaller compatible peripheral systems, depending on the uses envisaged. There is much to be said for a custom-designed system associated with LAN connections.

The central unit should be capable of communicating on three ISDN lines (six channels), giving an available speed of transmission of 384 kbps. The unit should support 30 frames per second so that good quality motion pictures are obtained with minimal jerkiness. Since the cost of running a system is proportional to the number of

channels used, all of the features will not always be in use. For normal teaching to a distant site consisting of a class of less than 20 students, reasonably good quality pictures will be obtained using one ISDN line (two channels). This is provided there is not too much action and the teacher has had some training in the use of the medium. If the session includes a lot of action (motion), it would be best to use two ISDN lines (four channels). When it is necessary to display considerable detail, as in pathology where the tissue detail is to be displayed, it is usually necessary to go to three ISDN lines (six channels). In any event, whatever the immediate uses envisaged, the system chosen should be capable of supporting up to six channels.

With time, there are advances being made regularly. Most recent systems have three or more video input ports with RCA or S-video adapters. Some systems now also have a port for the connection of a VGA output from a computer and this allows transmission of both text and graphic material direct from a computer. It is possible to connect any device that produces a standard video image to a video conferencing unit. Some of the peripherals recently included in this area are video recorders, document cameras, digital cameras, output from an electron microscope and output from endoscopy monitors.

Of the above peripheral attachments, the digital camera is currently playing an increasing role in telemedical applications. With this device one can take a photograph and without the hassle of developing, printing and slide making, it can be sent to the distant site directly from the camera via the video conferencing unit or as an attachment to an e-mail. Some systems do not yet have a port to connect computer images directly. In that case, it is necessary to have an additional device that converts the VGA (or XGA) signal to a video signal (PAL or NTSC) to allow computer images to be sent to the distant site.

The audio quality is very important in video conferencing so that both the lecturer and the students can be heard at a normal level of speech. It is easy to concentrate on the video aspect and to regard the sound quality as an afterthought. When video and audio are compressed and transmitted, there are inevitable delays and poor synchronisation between the audio and video channels. These place high demands on audio technology and are magnified in multipoint conferences. This problem can even now be seen on live international television broadcasts. Deficits in audio quality are further magnified by poor room design. In the Middle East when females use veils, the far end teacher can have difficulty in picking up what the students are saying, especially with the quiet voices of females.

Many of these problems can be dealt with by using a high-quality microphone, such as an omnidirectional surface-mounted power microphone at each end with noise suppression and echo cancellation being part of the video conferencing system. The sound must also be balanced at both ends of the link. If it is too low, there are hearing difficulties whereas too high a setting can pick up extraneous noise and vibration. Additional microphones can, however, also be connected directly into the Codec and power microphones are available which fix into the ceiling.

Most systems come with a main camera and one or more auxiliary cameras. The main camera is capable of pan, tilt, zoom, etc. and it is motorised and can be controlled by a remote device. Many also have a tracking facility so that they automatically point to the person who is speaking. The newer models sometimes have built-in network support and even a built-in internet browser.

Multipoint video conferencing is useful when two or more sites are involved in collaborative work and essential when organising CME in several areas. It is still usually necessary to have a bridge (multipoint server) for this purpose, however.

Finally, when choosing a system, it is essential to choose one at this time which provides a good after-sales service. The UAE University was fortunate in having an excellent service and this proved vital for development. Other centres bought equally good systems, but in the absence of help in the early post-sales period, very little use was made of them. A further point of value is that although systems from different companies all boast high-quality performance and ready compatibility with other brands, this can only truly be guaranteed if a system transmits to the same type of system. There are some proprietary standards that each system has and those having the same protocols interact most effectively.

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