Benefits and drawbacks of telemedicine

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Summary
Telemedicine is a vast subject, but as yet there are limited data on the clinical effectiveness and cost-effectiveness of most telemedicine applications. As a result, objective information about the benefits and drawbacks of telemedicine is limited. This review is therefore based mainly on preliminary results, opinions and predictions. Many potential benefits of telemedicine can be envisaged, including: improved access to information; provision of care not previously deliverable; improved access to services and increasing care delivery; improved professional education; quality control of screening programmes; and reduced health-care costs. Although telemedicine clearly has a wide range of potential benefits, it also has some disadvantages. The main ones that can be envisaged are: a breakdown in the relationship between health professional and patient; a breakdown in the relationship between health professionals; issues concerning the quality of health information; and organizational and bureaucratic difficulties. On balance, the benefits of telemedicine are substantial, assuming that more research will reduce or eliminate the obvious drawbacks.

Introduction
Telemedicine is a vast subject, but as yet there are limited data on the clinical effectiveness and cost-effectiveness of most telemedicine applications. As a result, objective information about the benefits and drawbacks of telemedicine is limited. This review is therefore based mainly on preliminary results, opinions and predictions.

Many potential benefits of telemedicine can be envisaged, including:

- improved access to information;
- provision of care not previously deliverable;
- improved access to services and increasing care delivery;
- improved professional education;
- quality control of screening programmes;
- reduced health-care costs.

Improved access to information
Telemedicine can improve access to information for health professionals, for patients and for the population in general.

Information for health professionals
Electronic search engines such as MEDLARS, PUBMED and others have laid the foundation for a silent revolution that enables any health professional to have access to up-to-date ‘case-oriented’ information within seconds, via the Internet. Wireless computer connections mean that searches can even be conducted at the bedside. Full copies of articles in journals and books can be ordered and received as an attachment to an email message from a distant reference library. This application of telemedicine provides the basis for daily, continuous education, which should expand and maintain the skills of health professionals at all levels. The benefits of this application of telemedicine are obvious and cannot be overestimated.

Communication between health professionals
Communication between the primary and secondary health-care sectors has traditionally been carried out by
mail, but email is increasingly being used for this purpose. As a result, information kept in a computerized data file can be attached to an email message, permitting easy and instantaneous transfer of patient information between general practitioners (GPs) and hospitals. Health professionals in primary care can access patient records, kept in databases of individual hospitals, groups of hospitals or entire health regions, ensuring, for example, that hospital discharge letters are made available without delay.

Information for patients and the general population

In many countries, computers in schools, homes, workplaces and local libraries allow electronically stored information to be accessed through the Internet. This has provided an opportunity to establish a ‘superhighway’ to information about health and disease, which can be used for many purposes:

- **To provide information to patients**: for understanding the nature of their disease, its prognosis, the reasons for carrying out certain investigations, and the effect that any treatment might have. Once patients have acquired such knowledge, it could provide the basis for shared decision-making between patients and health professionals, empowering patients and encouraging self-help. It is therefore crucial that information is accurate and case-oriented (though see below under ‘Drawbacks’).
- **To provide information to the general public** and in particular to the disadvantaged/under-served: for example, as part of health promotion or health education to people, schools and health-care centres. This could turn out to be the most cost-effective way of improving knowledge about health and disease, and the relationship between lifestyle and the quality of life. In practice, however, the value of this method of providing information will ultimately depend on the quality and presentation of the information (see below under ‘Drawbacks’).

Multimedia presentations on health and disease can also be considered to be telemedicine. Such presentations have the potential to overcome problems with illiteracy. However, they are often futuristic in their approach and may raise unrealistic expectations among the general population. Sensible and directed presentations, supplemented with additional information, for example, via the Internet, may redress some of the past and present difficulties associated with some of these presentations.

Provision of care not previously deliverable

In the 1980s, the Norwegian government initiated a national telemedicine programme. The main reason was to offer citizens in small, rural communities an alternative to travel, because of local deficiencies in specialist care. Overall, this political initiative has been vindicated and has been replicated subsequently in other parts of the world, including Australia, Canada, Greece, Japan and the USA.

Considered from this socioeconomic perspective, telemedicine has contributed to providing health care to previously under-served regions. However, the effect of telemedicine on delivering care in a local context, i.e. within a community or even within a hospital, should also be considered. There is the potential for telemedicine to have an even greater impact in these environments because of the much larger number of medical episodes that would be likely to occur. Such applications of telemedicine have only recently been considered.

Improved access to services and increasing care delivery

For many years, the telephone has been extensively used by health professionals and patients for keeping in touch. This is widely viewed as an effective form of telemedicine. Advances in communications technology have, however, increased the potential methods and speed by which health-care professionals and patients can communicate. Expected benefits of such improvements in communication are:

- faster access to the health professional;
- increased convenience, and time savings for patients;
- improved equity of access to care between and within regions, previously denied because of such factors as socioeconomic constraints, especially in countries in the developing world, and the tendency for specialized services to be centralized in urban centres;
- improved access between and within primary, secondary and tertiary care;
- improved quality of care.

Telemedicine may improve access in primary care and in secondary care.
Improved access in primary care

In primary care, telemedicine may facilitate communication with the GP; it may also improve access for patients at home.

GP consultations

Many consultations in a GP’s surgery relate to minor ailments such as respiratory and gastrointestinal infections, back pain and renewal of prescriptions. Once the diagnosis has been established, the effect of treatment needs to be monitored. This could be provided by videolink. Additional prescriptions could be sent via the Internet to a nearby pharmacy, which would arrange for delivery to patient. Such an approach could be beneficial for patients, especially if they were not well enough to travel. It could also be beneficial for the health professional, as the teleconsultation could take place at any time, and for the pharmacy, as its dispensing service could be better planned. There is evidence that such an approach could work.4

Home monitoring and treatment

Home monitoring and treatment of patients suffering from a wide range of diseases would improve the quality of care and be more efficient. The five examples given below illustrate how telemedicine could facilitate such improvements.

(1) Diabetes. Patients with diabetes mellitus need regular monitoring in order to minimize long-term complications. Diabetes mellitus is increasingly being diagnosed in younger patients with busy work schedules and other commitments. Traditionally, monitoring has required regular visits to outpatient clinics, which are often time-consuming and can result in substantial interference to a busy work or home schedule. Much could be gained by providing at least part of the monitoring required by such means as teleconsultation. This would minimize the effect of medical intervention on daily life, and provide an opportunity for health professionals to observe patients in their homes, potentially more frequently than at present.

To augment the above, assays are now available to allow home testing of blood and urine glucose levels (Figure 1). If performed correctly, the results of such assays can be as accurate as those carried out in specialist laboratories, although in practice the results of tests carried out by patients often differ from those performed in laboratories.3 This is not surprising as patients usually lack the training required to carry out laboratory investigations. However, this situation could be substantially improved if health professionals used the teleconsulting equipment to observe how patients carry out the tests. Glucose analysers could also be linked to the telephone, transmitting the results of tests performed to the health professional’s office. This option could potentially be used both for monitoring the frequency and outcome of tests carried out by the patient, and for registering the results obtained from control samples sent to the patient’s home to check the accuracy of the analyser.

(2) Hypertension. One important reason why patients suffering from high blood pressure visit health professionals is to have their blood pressure taken. As electronic blood pressure monitors are now available, patients can measure their own blood pressure and transmit the results, for example, to their GP, by telephone. Prescriptions of medication could subsequently be based on the transmitted results and arranged as discussed above. It might be expected that such an approach, where blood pressure measurements are taken at home and work, would result in the recording of more representative blood pressure readings, and might even reduce the number of patients with ‘white-coat’ hypertension. To ensure that readings were being accurately recorded, patients could initially be supervised using an inexpensive audiovisual link.6

(3) Home deliveries. In industrialized countries, there has been an increase in the number of home deliveries over the last decade. Although only uncomplicated pregnancies are recommended for home delivery, complications can still occur. In such situations, midwives could potentially receive immediate advice from an obstetrician in a secondary care institution using an interactive videolink. Such measures, although clearly not a substitute for high-quality specialized care, might improve the quality of service in some scenarios, to the benefit of both mother and neonate, as well as providing the midwife with continuous professional education. It is likely that developing countries would benefit even more from having access to monitoring of home deliveries, partly because the incidence of complications in these countries is higher.7

(4) Home nursing, care for the elderly and chronically ill. It is important that the mental and physical needs of the elderly and chronically ill are supported, so that they can continue to remain out of hospitals and other institutions for as long as possible, despite having age-related handicaps and illnesses. This can improve their quality of life, as well as reduce the costs of prolonged stays in community and hospital care facilities (Figure 2). The installation of home monitoring systems that could monitor physiological variables, such as the electrocardiogram (ECG) and blood
pressure, and videolinks that would allow health professionals and relatives to interact more frequently with the elderly, could go some way to achieving this. In effect, a ‘virtual home’ for the elderly and their relatives could be developed, which would permit relatives to take more responsibility for caring without having to compromise their own commitments. Such measures could also help to diminish the reportedly high incidence of abuse of the elderly by creating a more open, safer and happier virtual environment for institutionalized care.

(5) Dialysis. In the past, patients with renal failure have had regular dialysis treatment in hospitals on a day-patient basis. This has been very time-consuming for patients, for example preventing them from continuing their employment or applying for daytime jobs. Home dialysis under the supervision of a dialysis centre using a videolink could provide a solution to this problem for many patients, improving their quality of life and allowing them to work regular hours. It is also likely that dialysis centres could monitor more patients by such techniques. The obvious advantage of a videolink is that staff at the dialysis centre can observe how patients are handling the dialysis equipment and guide the patients in case of complications.

**Improved access in secondary care**

Telemedicine may improve access to hospitals. It may also improve access both between and within hospitals.

*Emergency specialist support*

An example of an emergency situation that might benefit from use of a videolink is a major traffic accident involving a number of cars on a busy road, all lanes being blocked in both directions by damaged and queuing cars, preventing access by ambulances. In such a situation, health professionals could still reach the site of the accident by motorcycle or helicopter. A portable audiovisual system, transmitting perhaps by...
microwave,\textsuperscript{10} would permit links with the nearest accident and emergency (A&E) department. Although there are still technical problems to solve, the same type of equipment installed in an ambulance could also provide a similar service both to victims of accidents and other emergency situations, and improve the quality of care during the transport of the victim(s). As ambulances are often staffed with health professionals trained in emergency medicine they could, under the supervision of specialists in the A&E department, be more interventionist in their approach during transit.

Similar services by videolink have already been established for emergency situations at sea, on aircraft and as part of rescue operations in major civil disasters.\textsuperscript{11} The US Navy has many vessels equipped with videolinks, enabling the general surgeons on board to link up with specialist centres by satellite for advice about how to handle complicated injuries.\textsuperscript{12} In the case of a major civil disaster, similar services could be provided by a mobile audiovisual system, carried to the site of the disaster by a helicopter. The helicopter could also function as a relay station for the telecommunications required.

Figure 2  Videoconference with specialists at the Toronto Children’s Hospital concerning a wheelchair for a severely handicapped child in Hong Kong. (a) The conference room with the Toronto specialists to the right on the screen; (b) the patient (deformed chest due to Duchenne’s disease, requiring support in the wheelchair for breathing; (c) early stage in building the wheelchair; (d) the patient on his way into the conference room (Photograph credit: M Hjelm)
to be said that the costs and benefits of such schemes remain to be established.

Inter-hospital access

Many medium-sized hospitals provide 24 h cover for specialist services while others provide only a skeleton service. Telemedicine could substantially improve this situation and reduce disparities in the level of cover between institutions. In radiology, there are already many hospitals where images are taken locally by a radiographer and then transmitted electronically to a radiologist somewhere else, for interpretation. Since there is a much larger pool of specialists at the specialist hospital than the smaller hospitals can muster, the quality of service is undoubtedly improved (Figure 3). The obvious advantages to the local radiologists are more regular working hours and continuous education. It is estimated that this new system is no more expensive than the old one.

The provision of specialist services to manage inpatients, at district general and other small hospitals that do not have specialists on site, by teleconsultation has also been tried. In many specialties, it has been shown to be an effective way of providing high-quality care that otherwise would not be available, e.g. in psychiatry.14

Intra-hospital access

So far, apart from applications for teaching purposes, there are few reported examples of telemedicine applications that improve intra-hospital access. However, there is a precedent for this in the telephone, which is already extensively used to provide many services, ranging from interpretation of laboratory investigations to a second opinion about a patient. There is no doubt that the effectiveness of these consultations is often restricted by the absence of the visual element, limiting the ability of health professionals to make accurate clinical decisions without seeing, for example, the radiological image or the patient. As a result, busy health professionals lose much time rushing up and down the stairs of large hospital complexes or queuing in front of elevators, in an attempt to reach patients quickly. The introduction of an audiovisual infrastructure in the hospital setting that could link wards, operating theatres, clinical service departments and doctors’ offices by a local broadband network might considerably improve this situation. For example, by using videolinks:

- surgeons and pathologists could discuss the best site from which to take a tissue biopsy and jointly review any frozen section taken;
- consultants could supervise junior medical staff, providing them with a second opinion on wards, in outpatient clinics and the A&E department;15
- pathologists and radiologists could provide an immediate service ‘at the point of care’.16,17

In general, it can be predicted that in hospitals the audiovisual presentation of information will gradually replace the telephone as a more cost-effective means of bridging ‘short distances’ (Figure 4).

Improved professional education

The provision of undergraduate, postgraduate and continuing training by electronic means has proved to be highly successful.18,19 Many undergraduate students use a laptop computer from the day they begin their first course, for such activities as downloading printed materials, videos and tutorials, and accessing medical information.

At the postgraduate level, examples abound of telemedical applications being used for the purpose of education. Examples include the self-test applications for some specialties that can be accessed on the Internet, the ability to access lectures given by distant specialists using videoconferencing facilities, and more recently the setting of simulators for teaching practical skills, such as intubation for anaesthetists and endoscopy for surgeons. Examination of undergraduate and postgraduate students by videolink has also been conducted, saving the school travel expenses and the examiner travelling time.

Figure 3 Teleradiology. Transmission of computerized tomography scans to a neurosurgery centre allows an informed decision to be made about the merits of transfer. The transmitting and receiving centres can view the same image on their monitors and use the telephone for comments (Photograph credit: M Hjelm)
It is safe to predict that telemedical education will rapidly become an integral part of the teaching curriculum for most health professionals, improving their access to a wide range of courses of the highest quality. For example, three-dimensional images of a joint or a skull could be downloaded, allowing surgeons to acquire manipulative skills by practising on the virtual image using real surgical tools. Downloading a virtual patient could provide health professionals with an opportunity to develop their consultative skills.20

Quality control of screening programmes

The success of mass screening programmes, such as those used for the detection of breast cancer and cervical cancer, depends on the use of specific and sensitive methods, which give reproducible results in all centres carrying out the tests, over long periods of time. Usually, external quality control programmes achieve this via the postal distribution of radiological images and pathological slides, for example. Using the Internet and other more advanced telecommunications methods for distribution has been shown to result in a much faster turn-around than is possible in conventional quality control programmes. Such programmes could, however, also be enhanced by using other modern methods of communication, which might include realtime demonstrations of images transmitted by videolink to participating sites from a dedicated centre.17

Reduced health-care costs

Large-scale trials have yet to be carried out for most telemedical applications. As a result, there is little quantitative information about the savings resulting from using telemedicine instead of traditional methods of providing care. So far most applications have focused on bridging large distances, caring for patients in remote or inaccessible areas. Such applications are often quite expensive because of the prevailing telecommunications costs.

In the long term, telemedicine could dramatically reduce the overall costs of health services because of its potential to allow a fundamental restructuring of the way health care is delivered. This would principally result from redistributing resources from the hospital environment into primary care. Providing more services in primary care and ultimately in patients’ homes could be considered to be the ultimate goal for health-care delivery and in part this could be facilitated by telemedicine.

Drawbacks

Although telemedicine clearly has a wide range of potential benefits, it also has some disadvantages. The main drawbacks of telemedicine that can be envisaged are:

- a breakdown in the relationship between health professional and patient;
- a breakdown in the relationship between health professionals;
- issues concerning the quality of health information;
- organizational and bureaucratic difficulties.

Breakdown in the relationship between health professional and patient

It should not be assumed \textit{a priori} that the use of teleconsultations will result in a breakdown in the patient–doctor relationship. The telephone has functioned very well as a communications medium...
without any documented indications of it decreasing the quality of the communication between patient and doctor. Teleconsultation may even improve the relationship, for example in matters concerning sexuality and family problems, where a psychological ‘safety distance’ may make the patient more open and forthcoming.\textsuperscript{21} Therefore, the risk of breakdown in the relationship from using a videolink might relate more to communicative skills and lack of formal training in using telemedical equipment rather than the format of the communication itself (see below under ‘Depersonalization’). However, more research is required if the optimum procedure for interacting with patients by videolink is to be established.

Factors which might cause a breakdown in the relationship between health professional and patient compared with normal face-to-face consultations are:

- physical and mental factors;
- depersonalization;
- different process of consultation;
- inability to perform the whole consultation;
- reduced confidence of patients and health professionals;
- different knowledge and skills required of health professionals and ergonomic issues.

Physical and mental factors

Patients suffering from reduced vision or who are hard of hearing are likely to have some difficulty following the information presented in a video consultation. It seems, however, that by displaying questions as text and using sign language, these limitations can be overcome.\textsuperscript{22} Videoconsultations have been successfully carried out with disabled patients.\textsuperscript{23}

Depersonalization

During a teleconsultation, the images of both the health-care worker and the patient are projected onto a monitor and all interactions between the two parties are indirect. As our perceptions of what is seen on a monitor are very much influenced by our experience of watching TV, a teleconsultation might not be experienced as being real by either party. There is anecdotal evidence that elderly patients at times do not accept that a physician, appearing on what looks like a TV screen, can see and listen to them properly. In one instance, a resident in an old people’s home participating in a trial asked the female research assistant sitting next to her to repeat what was said by the male physician on the monitor, and finally asked the research assistant, ‘Why are you talking to me in a man’s voice?’ (Hjelm et al., unpublished work).

Different process of consultation

During face-to-face and telephone consultations, patients and health professionals introduce themselves in a natural way as part of the consultation, and in doing so secure the identity of both parties. However, it is observed that this important introductory step is often omitted during a videoconsultation. The reason for this omission is uncertain but could perhaps be explained by technical distractions or it may reflect the fact that when watching TV, the identity of the actors is often not important for understanding what is going on.

Both health professionals and patients should be asked to identify themselves at the start of a teledmedicine session and the patient should be told briefly about the technical aspects of the session and asked about the quality of the audiovisual transmission.

Inability to perform the whole consultation

A videoconsultation is limited by the fact that the entire physical examination cannot be carried out over a videolink. This particularly applies to examinations where palpation is an important component. In such cases, the specialist has to rely on the findings of another health-care worker, whose examination of the patient they have witnessed and, in practice, this often seems to be satisfactory. These limitations may gradually be removed by future technological developments, which will allow the investigator to carry out examinations indirectly that at present are impossible.

Confidence of patients and health professionals

In general, patients seem satisfied with most telemedicine applications, including teleconsultation,\textsuperscript{24} and health professionals have expressed confidence in using, for example, videolinks, for providing care.\textsuperscript{25} There is however some scepticism about if not open hostility to the use of telemedicine among a proportion of health professionals. Evidence gained from properly conducted clinical trials is likely to be the only way to change such opinions.

Different knowledge and skills required of health professionals and ergonomic issues

There is no doubt that the equipment required for telemedicine can sometimes be daunting to use. It is therefore essential, if users are not to be scared off, that sensible presentations of the applications are given, that do not overemphasize to the users what are essentially irrelevant technical details. During these
presentations, the skills required to operate the equipment should be taught. This is particularly important because at present there are few commercial video systems available at a reasonable price for dedicated use in the medical environment. Health-care professionals should therefore encourage the industrial sector to develop such systems according to their specifications. It is also important that the limitations of the equipment used are detailed. Some universities already offer ad hoc courses in telemedicine but such courses need to be incorporated, in the longer term, into the undergraduate curriculum of all health professionals.

**Breakdown in the relationship between health professionals**

This is an area that has not been explored to any great extent, although there is the risk that highly skilled staff at the remote site will perceive that their autonomy is threatened by the use of telemedicine, or worse still that they will become no more than technicians, acting solely as the hands of the specialist, who will receive all the plaudits for performing a consultation.

**Issues concerning the quality of health information**

As indicated above, there is a wealth of medical information available via the Internet. This can be broadly divided into three categories:

- textbook-style information, produced by medical schools and other academic institutions;
- abstracts of peer-reviewed articles or whole articles in biomedical journals;
- health pamphlets and articles intended for the general public, produced by individuals, charitable organizations or special-interest groups.

It is the information in the third category that gives the greatest reasons for concern, as far as patients and other non-health-care professionals are concerned, because the content can be biased, inaccurate, confusing and misleading for a patient seeking information about a particular condition. As with all printed information, medical information on the Internet should contain relevant, research-based data in a form that is acceptable and useful to patients. To facilitate this, guidelines should be worked out for the production of medical information directed at patients and the general public; this might involve including a review process and a ‘kitemark’ to indicate that the information is accurate and meets recognized standards.

Problems with the wealth of information available can, however, also affect the health-care professional. This principally arises not because of quality but because of the seemingly endless quantity of information available. The concept of information overload is already a reality for many health-care professionals, since it appears to be impossible to keep up to date with developments. This is also the case in the telemedicine field, as witnessed by the huge increase in publications on the subject.

**Organizational and bureaucratic difficulties**

The fact that telemedicine might have great potential for improving health-care delivery does not necessarily mean that it will be implemented. In fact there is little evidence that manufacturers, who are able to develop and manufacture suitable commercial products, politicians, who could promote an environment where funding would be available, health administrators, who could change existing health-care delivery systems, or health professionals, who could guide and implement such changes, are particularly interested in doing so.

The (US) Western Governors’ Association Telemedicine Action Report in 1994 listed six ‘telemedicine barriers’ that could hinder the implementation of this method of health-care delivery:

1. problems with infrastructure planning and development;
2. problems with telecommunications regulations;
3. problems with reimbursement for telemedicine services, because of absent or inconsistent policies;
4. problems with licensure and credentialing, because of conflicting interests with regard to ensuring quality of care, regulating professional activities and implementing health policies;
5. problems with medical malpractice liability, because of uncertainties with regard to the legal status of telemedicine within and between states;
6. problems with confidentiality, because of the increased risk of unauthorized access to patient information compared with information on paper.

The report was updated in 1998,26 but overall, little progress had been made to eliminate barriers 1, 2, 3 and 5. Furthermore, barrier 4 had, if anything, been raised, even though barrier 6 had in effect been eliminated, because electronic transmission of patient information can now be considered to be as safe as conventional methods of information transfer. The lack of progress over a four-year period indicates that much work still remains to be carried out both in the USA and...
elsewhere in the world before an integrated master plan for telemedicine based on political, professional and economic consensus will emerge.

Other difficulties in implementing telemedicine are likely to arise in trying to convince health-care workers that they should change the way in which they work. The reasons for resistance to change are manifold but include, in addition to those points detailed in the (US) Western Governors’ Association Telemedicine Action Report of 1994:

- Lack of evidence as yet for the efficacy or cost-effectiveness of most telemedicine applications. The solution to this is therefore to evaluate any telemedicine application properly.²⁷–³⁰
- Perceived threat to the role and status of health-care workers.
- Fear that telemedicine will only increase the current workload of health-care workers, especially in any transitional phase.
- Fear that telemedicine is market-driven, rather than being user-driven, with the risk of market-driven abandonment of products and technologies.
- Fear of technological obsolescence resulting from rapid technological advances.
- Lack of consideration of knowledge and skills of users.
- Cultural and linguistic differences.
- Lack of agreed standards.

Many of the above points are included in the concept of clinical risks related to telemedicine. These are dependent on the level of skills among health professionals and the documented reliability of techniques and procedures used for either diagnostic or interventional purposes. At present, most health professionals are not trained in telemedicine, and there is still little hard evidence for the efficacy or otherwise of telemedicine applications. Therefore, research into obtaining information about the clinical risks associated with telemedicine should be assessed.

Conclusion

Telemedicine has the potential to augment conventional methods of health care so that one day high-quality health care will be available to everyone, everywhere. How telemedicine might achieve this is principally by increasing equitable access to health information and by improving its exchange throughout the entire health-care pyramid. Such a vision will only be possible, however, if telemedicine development is dictated by health needs, if all applications are properly evaluated, and if they are then integrated into the overall health infrastructure. On balance, the benefits of telemedicine are substantial, assuming that more research will reduce or eliminate the obvious drawbacks.

References

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