

VIRTUAL REALITY IN A CHILDREN'S HOSPITAL

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Abstract: We used virtual reality technology to improve the quality of life and amenity of in-patients in a children's hospital. Children in the hospital could enjoy a zoo, amusement park, and aquarium, in virtual. They played soccer, skiing and horse riding in virtual. They could communicate with persons who were out of the hospital and attend the school which they had gone to before entering hospital. They played music with children who had been admitted to other children's hospitals. By using this virtual technology, the quality of life of children who suffered from psychological and physiological stress in the hospital greatly improved. It is not only useful for their QOL but also for the healing of illness. However, these methods are very rare. Our systemic in our children's hospital is the first to be reported in Japan both software and hardware of virtual reality technology to increase the QOL of sick children need further development.

In recent years, the forms of diseases have greatly altered due to the advances in diagnostic technology and therapeutic techniques, and the percentage of chronic diseases, so-called intractable diseases, has increased while that of acute diseases has decreased. Diseases called intractable usually require long-term treatment, because their etiologies have remained unclear, or because there are no established therapeutic regimens, even if the etiologies have been clarified. Children with intractable diseases have to stay in hospital for a long time for diagnosis and treatment, and their activities in daily life are markedly restricted. In other words, their quality of life (QOL) is greatly impaired. Needless to say, diagnosis and treatment should have priority, but it is also important for treatment that the associated mental and physical stresses are reduced as much as possible, and that the QOL is maintained.

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1. Impairment of QOL by Hospitalization

(1) Communication Deficiency

Children are isolated from families and friends and also from society when they have to stay in a hospital over a long period of time for examination or treatment, resulting in marked scarcity of communication with out-of-hospital people and collection of information. Communication and information collection are essential nutrients to life and are also very important for the mental and social development of children. Telephones installed in a hospital and interviews with a few people are usually the only means of communication with the outside. Lack of information and communication results in the impairment of patients' QOL.

(2) Deficiencies in Exercise

Moving of the body is not only good for the body itself, but also for the elimination of mental stress. However, hospitalized children are deficient in exercise, because they live in a closed space, such as a bed, ward, or hospital. Hospitals are places where available space for exercise is limited, and such space is a poor environment for exercise, giving the children no encouragement.

(3) Deficiencies in Education and Learning

Since humans have the instinct of learning, mental stress is imposed on children when they are isolated from the learning environment, as they are in a hospital. Learning and education are essential, particularly to children, who spend most of their time studying and learning. However, there are only limited facilities and opportunities for learning within a hospital. Thus children gradually lose their will to study and also then creativity when they stay in hospital for a long period.

(4) Insufficient Opportunities for Actual Experience

Long-term hospitalization takes away from pediatric patients the opportunity to have common experiences that healthy children routinely have, such as walking in a town, travelling by train, or going to a zoo, amusement park, or concert. Since children develop mentally and acquire social roles through various experiences, such deficiencies not only impose mental stress on the children, but may also induce unbalanced development.

(5) Deficiencies in Pleasure

The inside of a hospital is a place with a marked scarcity of entertainment. Hospitals have very few facilities for entertaining or relaxing patients, which at most consist only of televisions or a videocorder (Fig. 1).

In addition to these environmental factors, children often have to undergo invasive tests or treatment during hospitalization, because current medicine often requires large-scale intervention, which is often painful and agonizing. Thus children have mental stress and fear such examination and treatment as well as side-effects, which impair their QOL.



Fig. 1: 15-year-old boy with muscle dystrophy who has lain in bed for a long time. There are only a TV set and tape recorder around his bed for his amenity. His quality of life in hospital is poor.

2. Application of VR Technology to the Improvement of Children's QOL

Although various attempts have been made to improve inpatients' QOL, they cannot always provide a satisfactory outcome. Communication technology has recently advanced tremendously, giving simultaneous mutual communication with many distant places, which virtual reality technology produces a feeling of reality, a high vision technology provides very clear images. Thus these technologies are thought to be suitable for children who need communication, experience, exercise, learning, and pleasure within a hospital. At our National Children's Hospital, we have attempted to improve children's QOL using such latest VR technology since 1993. We herein report our attempts, together with the future potential of VR.

Many of the attempts described below were conducted by the Children's Media Study Group.

(1) "Let's Go to a Zoo!"

A system, called "Let's go to a zoo!", by which one can freely walk in a zoo by means of 3-dimensional images, was installed in 1993 at the National Children's Hospital. This system was the first VR-related technology used in a hospital in Japan, offering a chance of improvement of patients' QOL by VR

technology applied to medical practice (Fig. 2). Since this system provided stereoscopic images and gave every child a free walk at will through a zoo, different from videotapes, the children had a real feeling that differed from the one-way presentation of a hour through a zoo on a conventional videotape. This system provided children with pleasures and experiences which they could not have in a hospital. After that, different version, such as "Let's go to a park", in which children could walk in a park, ride a roller coaster, and so on, were prepared. Children rather preferred scenes that healthy children see in everyday lives to exciting stories, such as wars, racing cars and complicated games. This was because hospitalized children are deficient in the activities of everyday life.

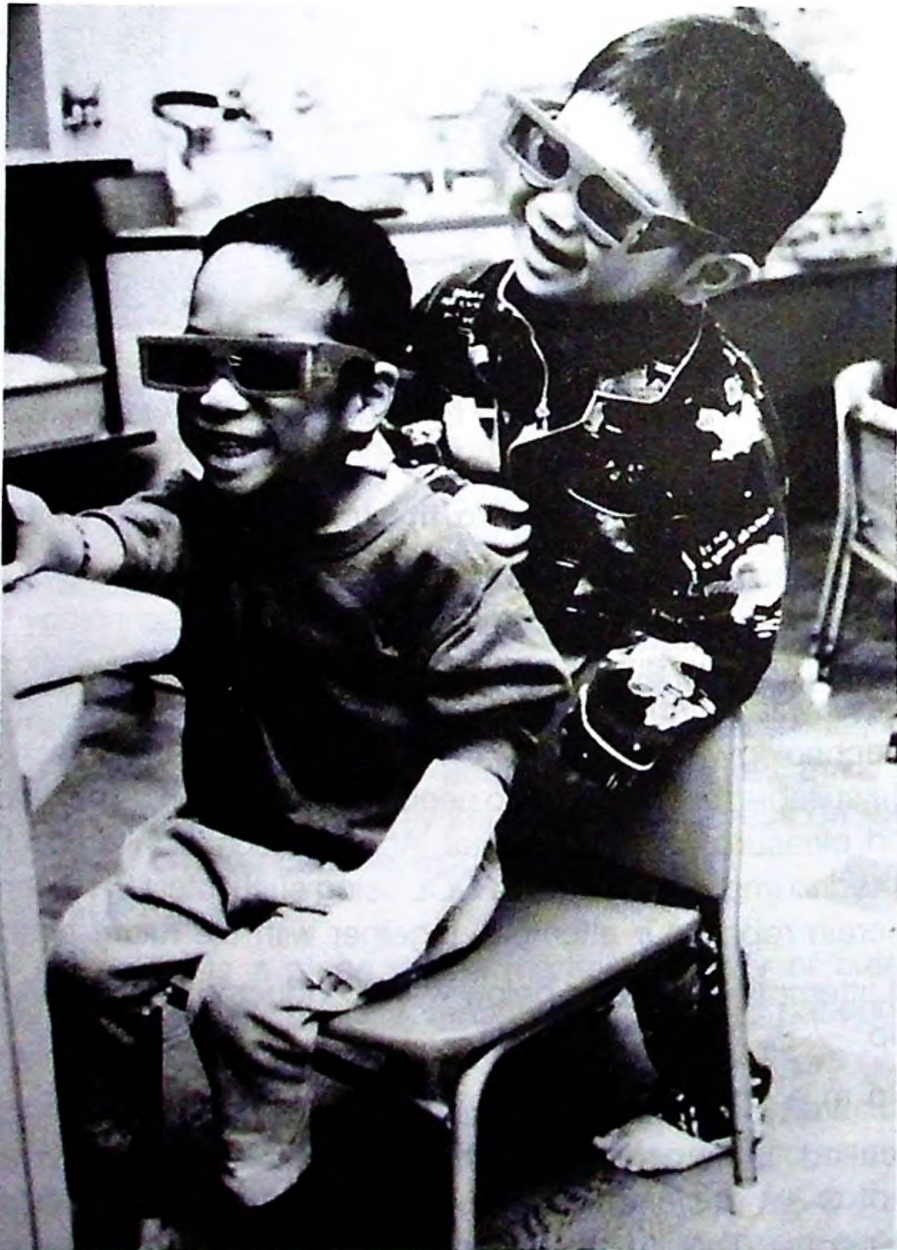


Fig. 2: Children play and enjoy a virtual zoo, called "Let's go to a Zoo!".

(2) VR Aquarium

Clear images on a large screen can give a real feeling, although they are not stereoscopic or bidirectional. A high-vision aquarium on a large screen which we attempted simply provided images of tropical fishes swimming freely, but greatly relaxed patients. This program was preferred to many other VR programs. Although it is ideal that a real aquarium should be built up in a hospital, this is difficult because of questions of economy and safety. This VR aquarium had such a role. Many hospitalized patients are in a physically and mentally negative condition, and they often prefer just watching images to doing something. We also attempted to give natural sights, such as mountains and rivers, as well as sights in a town. These images were also found to be effective.

(3) VR Skiing

We installed a VR skiing system in our hospital. Each child, who actually wore skiing shoes and held stocks, skied on a slope projected on a large screen while balancing with the legs and changing direction. This system gained the greatest reputation during the testing period, and many children used it (Fig. 3). Children who were thought to be unable to go to a skiing ground and those who could not go out of the hospital due to ongoing treatment for such conditions as leukemia could enjoy virtual skiing. This system also provided useful experience and was a form of rehabilitation. Although it was a large-scale system, it definitely merited installation in a hospital.



Fig. 3: 10-year-old boy with leukemia plays virtual skiing.

Other than this system, a VR horse riding system was also prepared for the same purpose. Although horse riding is considered to be effective as physical and mental rehabilitation because movements to keep a 3-dimensional body in balance, and certain up-and-down rhythms, stimulate the brain and body, it is impossible to bring a real horse into a hospital. VR horse riding, however, can serve as useful rehabilitation. A virtual driving system with 3-dimensional high-vision images is useful for children who have lain in bed (Fig. 4).



Fig. 4: 15-year-old boy with muscle dystrophy enjoys a virtual driving system with 3-dimensional high vision image.

Such VR sporting systems effectively provide patients with exercise, experience, and pleasure, and are expected to be further developed.

(4) VR Interviews

Isolation from out-of-hospital communication is a serious problem. Interviews made at the present time within wards cannot be said to be sufficient because of many limitations, such as the number of people attending an interview and restrictions of space and time. Through interviews on images, it is possible to see people who cannot come to the hospital frequently due to time restriction or long distance. When we arranged VR interviews between children in wards and their relatives or friends in distant places through images, they were found

to be of sufficient significance as interviews (Fig. 5). In another case, we made an attempt to improve the QOL of both a mother with leukemia and her child with muscular dystrophy under the aid of artificial ventilation, who stayed in different hospitals far from each other, by connecting their bedsides with images to see and communicate with each other at any time they wanted (Fig. 6).



Fig. 5: Children in hospital communicate with their families through a large screen.



Fig. 6: Boy with muscle dystrophy communicates with his mother who entered other hospital for treatment of leukemia.

Further, we also arranged communication between patients in children's hospitals distant from each other through a concert, a Christmas party, dancing, and playing ping-pong by connecting our hospital to others using a communication channel.

(5) VR Classes

Although opportunities to learn and study are impaired in a hospital, it is possible to have classes through pictures. We attempted to let children have classes in a distant hospital school or through VR with their classmates in the school which the children had attended until hospitalization. Because education is essential to children's lives, it is ideal to have classes while staying in hospital.

(6) VR Soccer

VR soccer was not performed in the hospital, but on the shores of Yamanaka Lake, to which we brought children with intractable diseases for a summer camp. Children played soccer (PK game) as follows: while the campground was connected with a soccer ground in Yokohama through a satellite telecommunications system, the strength and direction of a soccer ball kicked by a child in the Yamanaka Lake campground near Mt. Fuji were sensed, and the ball was transported into the Yokohama soccer ground through images and caught by a keeper.

As our next plan, we are attempting to hold a VR World Cup through VR soccer games between children hospitalized in Japan and in other countries.

The main VR systems that we attempted to use during the 4-year period have been shown. These systems were thought to be effective for the release of hospitalized children from mental and physical stress, even to a small extent.

VR technology should be used to break the wall of a closed space, a hospital, and to make everyday lives of hospitalized children as close as possible to those of healthy children. Thus both software and hardware should be further studied and developed.

3. Future Development

(1) VR as Rehabilitation

Rehabilitation can be achieved by the use of VR by patients. When used for rehabilitation, there are physical and mental approaches. For physical rehabilitation, training can be performed in a pleasant virtual space, although it is normally done in a rehabilitation room at the present time. Programs such as VR golf and VR horse riding are also thought to be useful for rehabilitation. These programs are expected to be prepared in the future.

We developed a VR miniature garden therapy and applied it to clinical cases. Many others plans have been made to apply VR technology to the rehabilitation of claustrophobia, anthropobia, etc. We expect to see the establishment of these programs.

(2) Application to Informed Consent

Many patients cannot form images of their post-treatment state of future pathological condition although doctors explain them as precisely as possible. If such patients have previously experienced their future states through VR, they can have realistic images, facilitating their understanding. Moreover, if patients are experienced in VR conditions close to the advanced states of their diseases, they can mentally prepare themselves for such conditions and will not be in a panic when they read this state.

(3) Support of Parents' Groups

Parents having children with intractable diseases desire to collect accurate medical information, to exchange information with other parents, and to receive medical care for their children from specialized doctors. Because of this, such parents have organized parents' circles as well as patients' circles, and the parents and patients have meetings to exchange information and receive treatment. We are now planning to provide communication between parents, medical consultations with doctors, medical information, and lectures by doctors in VR space.

(4) Application to the Nursing of the Elderly

Although our attempts have been made for children, mainly in our children's hospital, they can also be applied to the nursing of the elderly if viewed from different points. Problems for the elderly include deficiencies in experience, communication, exercises, learning, and pleasure which are generally considered as problems for hospitalized patients. With aging, people have less chance to have such opportunities and are also given less opportunities from those around them, and these deficiencies further aggravate aging. Development of VR systems for the elderly is thought to be useful for the nursing them and making them more active.

4. Current Difficulties in the Use of VR in Hospitals

(1) Difficulty in Development of Software

The current tendency of VR software development is directed to the development of software used in so-called game centers; namely, more exciting or game-playing VR software, but not such as is suitable for hospitals, patients, or the elderly. This is probably because programmers cannot understand the needs of hospitals or patients, and software for minorities has low economic value due to small market demand. Moreover, it is not clearly understood what physical and mental side-effects VR has on humans, resulting in limitations on its use in hospitals. We strongly hope that both software and hardware suitable for patients and the elderly will be developed to improve their amenity.

(2) People Who Can Understand Both Children and VR

Needless to say, human-to-human heartfelt communication is most important to maintain the amenity of patients and the elderly, and VR is a mere tool to help such communication. When VR is used in such cases, it rarely serves as useful tool if VR devices are just installed. They need the intervention of people who link the devices with humans, and such people have important roles. The reason for this deficiency is that no instructors have been allocated for VR. Because children staying in a hospital for a long time and aged persons requiring aids usually do not actively challenge themselves with new tools, VR cannot exert its effects if no instructors to guide children or the elderly are present. At the present time, it is difficult to recruit persons who can understand both children and VR technology.

(3) Economic Difficulty

Current medical expenditure is paid from health insurance only for examination and treatment, but not for mental care or improvement of patients' amenity. Further, equipment and human resources needed for the improvement of patients' amenity are often sacrificed to increase profits from medical care. Therefore we have no available budget to purchase such devices or to hire persons to operate such devices at the present time. We must clear away many such difficulties before VR technology can be routinely used in the hospital.