Chernobyl Telemedicine Project

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Final Report of the Joint Project with
the World Health Organization,
the Sasakawa Memorial Health Foundation and
the Republic of Belarus

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List of abbreviations

- BelCMT: Belarusian Centre for Medical Technologies
- BSMU: Belarusian State Medical University
- EC: European Commission
- EU: European Union
- GSMD: Gomel Specialized Medical Dispensary
- GSMU: Gomel State Medical University
- HON: Health On the Net Foundation
- ICT: Information and communication technology
- IT: Information technology
- RCRMHE: Republican Centre for Radiation Medicine and Human Ecology
- RCTT: Republican Centre of Thyroid Tumours
- RSML: Republican Scientific Medical Library
- SMHF: Sasakawa Memorial Health Foundation
- WHA: World Health Assembly
Summary

As a result of the accident at the Chernobyl nuclear plant on 26 April 1986, enormous quantities of various radionuclides were released into the environment over large areas of Belarus, Russia and Ukraine. The huge amount of radioactive iodine that was emitted from the reactor caused a dramatic increase in thyroid cancer among children in the years following exposure.

Medical screening carried out in the affected countries from 1991 to 1996 by the World Health Organization (WHO) and the Sasakawa Memorial Health Foundation (SMHF) revealed this unprecedented increase in thyroid cancer in children living around Chernobyl. This large divergence from normal baseline incidence was almost certainly due to the uptake of short-lived radionuclides of iodine into the thyroid glands of neonates, infants and children.

In 1999, WHO and SMHF agreed to implement a project that would strengthen medical care facilities through the development of “health telematics”. Belarus was selected as the location for the telemedicine facilities since it suffered the greatest increase in childhood thyroid cancer and large areas of the country were highly contaminated.

The proposal to establish the health telematics project was supported by the positive outcomes of the earlier "Second Chernobyl Sasakawa Health and Medical Project". That project established a satellite-based telecommunication system between the Gomel Specialized Medical Dispensary in Belarus and the Nagasaki University School of Medicine in Japan in February 1999. In May 1999, immediately after the passing of World Health Assembly resolution 49.22, WHO and SMHF, in cooperation with the Ministry of Health of the Republic of Belarus, established a joint project called "Medical Relief for Children affected by the Chernobyl Accident through the Development and Implementation of Health Telematics". Funds for the project were provided through the Sasakawa Health Trust Fund.

Following a pilot study by Nagasaki University in 1998, development of the infrastructure needed to support telecommunications, telepathology (remote diagnosis of thyroid cancer) and tele-education activities started in 2000.

Activities undertaken within the framework of this joint project were the following:

- Establishment of a telemedicine network linking medical institutions in Minsk and Gomel, in cooperation with the Belarusian Centre for Medical Technologies, Information, Management and Health Care Economy (BelCMT). A further link was subsequently completed to the Gomel Specialized Medical Dispensary (GSMD), now called the Republican Research Centre for Radiation Medicine and Human Ecology (RCRMHE). The Government of Belarus designated RCRMHE as the responsible institute for all Chernobyl accident activities.

- Development of telepathology software and training of specialists by the Belarusian State Medical University (BSMU).

- Development of tele-education software for medical students and doctors by BSMU and Gomel State Medical University (GSMU).

The project was administered by a Management Committee, which provided general oversight and approval of the budget, and a Working Group, which managed the day-to-day implementation of the project. Members of these bodies are listed in Annex 1.
In July 2004, the completed telemedicine facility was launched in Gomel. Equipment provided to the participating institutions is listed in Annex 2, while Annex 3 summarizes the costs incurred during implementation of the project. The budget of US$ 1 million covered equipment and implementation; additional funds will be needed for any updates or expansion of the project.

The state-of-the-art telemedicine facility is now being used to great advantage, particularly by institutions that need help with diagnosis and treatment – not only of thyroid cancer but of all other pathologies – and has provided much-needed support for medical specialists in the remote areas of Belarus. In time, as the facility becomes better known among new specialists, its use will increase. However, as stressed in the recommendations that follow, there is a need to expand this facility to other areas of Belarus and beyond.

Increasingly, the facility is also being used for teleconferencing, especially among specialists in eastern European countries. For example, there are regular teleconsultations and teleconferencing between the key institutions in Gomel and medical facilities in the Russian Federation.

This report provides a detailed description of the Chernobyl Telemedicine Project, particularly its administration and implementation. Each of the participating centres was for a summary of the facility and activities, and the information they provided is included.
Recommendations

1. The Chernobyl telemedicine facility would benefit significantly from upgrading to higher data transmission rates. This would both reduce waiting periods and allow the use of new applications that would enhance the value of the system.

2. To improve the pathological review of thyroid cancer the telemedicine facility should be linked to the Chernobyl Tissue Bank project (web site www.chernobyltissuebank.com/). Improvement of the local network system for teleconsultation in the Gomel region would also be beneficial.

3. Resolution 49.22 of the 49th World Health Assembly (WHA) urged WHO’s Member States to participate actively in, and provide further support for, the implementation of programmes and activities that would mitigate the health consequences of the Chernobyl accident. The Chernobyl Telemedicine Project is one such programme, designed to help those affected in Belarus. Following adoption by the 58th WHA, in May 2005, of resolution 58.28 urging intensified efforts in the field of eHealth, it is recommended that the work of the Telemedicine Project be continued through the expansion of eHealth activities.

4. The telemedicine facility installed in the key medical and educational institutions in Belarus is world class and serves as a model for use by other such facilities, especially in eastern Europe. This facility should also become a model for Russian-speaking countries, since it contains unique information and training courses in that language. It is recommended that the telemedicine facility be used to interact with medical facilities throughout the world, but especially with institutions in eastern Europe that have similar interests.

5. The Chernobyl Telemedicine Project should be expanded to centres in Belarus and then to the Russian Federation and Ukraine. This should form the basis of a new proposal for funding.
1. Belarusian Centre for Medical Technologies, Information, Management and Health Care Economy

1.1 Establishment of the telemedicine infrastructure

The Project participants were the following:

- Minsk City
  - Belarusian Centre for Medical Technologies, Information, Management and Health Care Economy (BelCMT)
  - Belarusian State Medical University (BSMU)
  - Republican Centre of Thyroid Tumours (RCTT), based at the Minsk Municipal Clinical Oncological Dispensary
  - Republican Scientific Medical Library (RSML)
  - Municipal Clinical Hospital No. 9
  - Childhood Clinical Hospital No. 3.

- Gomel City
  - Gomel State Medical University (GSMU)
  - Gomel Specialized Dispensary for Radiation Medicine (now the Republican Centre for Radiation Medicine and Human Ecology – RCRMHE).

In 2001, during the first stage of the project, telecommunication equipment and computer facilities were purchased. BSMU carried out the tendering and purchasing of this equipment and its distribution to Project participants.

Development of the project and the laying of fibre-optic cable between BelTelecom, BSMU, RSML and BelCMT was overseen by BSMU.

BelCMT carried out the assembly and installation of the communication racks and equipment at BelTelecom and GomelObTelecom.

Establishment of RCRMHE also created the need for its connection to the telecommunication structure of the Telemedicine Project. BelCMT undertook the task of developing the design, and providing a documented estimate, for connection of RCRMHE to GomelObTelecom through a fibre-optic cable. As a result of its tender, BelABM was charged with laying the fibre-optic cable: laying of the cable, its connection to telecommunication equipment and line testing were completed by April 2004.

A telecommunication hub, to which all Project participants are connected, was established at BelCMT. BelCMT leases two SHD (Super High Definition) 64 kbps lines at BelTelecom – the state telecommunication provider – in order to connect participants from Gomel. The participants connected to the telecommunication hub at BelCMT are listed in Table 1, which also shows the speed of data transmission.

Figure 1 shows the entire Chernobyl telemedicine network involved in Minsk and Gomel, Belarus, and in Nagasaki, Japan. Installation of the telecommunication infrastructure is now almost completed, in line with the original plan. Tele-education and telepathology are in operation, using the established network lines.
Figure 1. Installation of telecommunication infrastructure in Minsk and Gomel

Table 1. Connection of Project participants, types of lines and data transmission speed

<table>
<thead>
<tr>
<th>Project participant</th>
<th>Type of line</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BelCMT – BelTelecom</td>
<td>Optic fibre</td>
<td>2 Mbps (Internet access – 256 kbps)</td>
</tr>
<tr>
<td>BelCMT – BSMU</td>
<td>Optic fibre</td>
<td>10 Mbps</td>
</tr>
<tr>
<td>GSMU – GomelObiTelecom</td>
<td>Dedicated line (copper wire)</td>
<td>64 kbps</td>
</tr>
<tr>
<td>RCRMHE – GomelObiTelecom</td>
<td>Optic fibre</td>
<td>100 Mbps</td>
</tr>
<tr>
<td>BelCMT – GomelObiTelecom</td>
<td>2 SHD channels (leased)</td>
<td>2 x 64 kbps</td>
</tr>
<tr>
<td>BelCMT – RSML</td>
<td>Optic fibre</td>
<td>—</td>
</tr>
<tr>
<td>BelCMT – RCTT</td>
<td>Dedicated line (copper wire)</td>
<td>64 kbps</td>
</tr>
<tr>
<td>BSMU – Municipal Clinical Hospital No. 9</td>
<td>Optic fibre</td>
<td>10 Mbps</td>
</tr>
<tr>
<td>BSMU – Childhood Clinical Hospital No. 3</td>
<td>Dedicated line (copper wire)</td>
<td>64 kbps</td>
</tr>
</tbody>
</table>
1.2 Project development and implementation

The telecommunication infrastructure of the project is operating smoothly, although introduction of more recent technology could significantly increase the speed of data transmission. Checks on performance, including a demonstration during an international seminar in Gomel (July 2004), provided a successful launch of the Telemedicine Project.

The Project was established to aid the diagnosis and treatment of thyroid cancer in children and to provide expert advice to clinicians for resolving urgent medical issues. However, rapid advances in local expertise have led to changes in the way the facility is used. For example, the incidence of childhood thyroid cancer has greatly decreased and the Project participants have changed. The high-capacity RCRMHE was established in Gomel, replacing the Specialized Dispensary for Radiation Medicine, certain regional institutes and also the Scientific and Practical Centre for Radiation Medicine in Minsk. Well-equipped outpatient and inpatient clinics are now available at RCRMHE. As a result of these changes, the Project should be extended, both to include more participating institutions and to modernize its telecommunication infrastructure and software.

The Ministry of Health has presented proposals for the further development of telemedicine in Belarus: telemedicine consultations are required by RCRMHE in the fields of haematology and oncology, cytology, ultrasound diagnosis, and ophthalmology.

At present, there is a need for teleconsultations between RCRMHE and specialists from RCTT on ultrasound diagnosis and diagnosis of cytological slides of thyroid pathology. Achieving this with maximum efficiency requires the following measures:

- Upgrading of data transmission speed between RCTT (Minsk) and RCRMHE (Gomel) from 64 kbps to 1–2 Mbps (see Table 1); replacement of existing modems to increase speed to 2–3 Mbps (estimated cost US$ 150–200 per unit); lease of higher-speed channels for Gomel (up to 1–2 Mbps) at an annual cost of US$ 5000–14 000.

- Special software and ultrasound diagnosis modules for physicians and cytologists from RCRMHE, as well as software for consulting physicians from RCTT. Specialists should be trained to work with these programs. BelCMT and the United Institute for the Problems of Information Science, affiliated to the National Academy of Sciences, have agreed to supply the necessary software to RCRMHE and RCTT and to test it under experimental conditions.

- Provision to the Ministry of Health of the necessary organizational and administrative documents for conducting teleconsultations.
2. Belarusian State Medical University

2.1 Introduction

The Chernobyl Telemedicine Project includes two main parts: tele-pathology to improve early and accurate diagnosis of thyroid pathology; and tele-education to strengthen education and training of doctors and medical students in Belarus, particularly those who work, or will work, in radio-contaminated areas.

Because the Belarusian State Medical University (BSMU) is one of the leading science-oriented universities in Belarus, especially for education and training, it was made the lead institution for the Belarusian side of the Telemedicine Project and developed the software with support from WHO, SMHF and Nagasaki University. This report summarizes the establishment of the specific software “virtual” environment using two major modules:

- tele-education information resources and software, and
- telepathology system, including image processor, data filling system, database and information security system, and data and image transfer system.

2.2 Establishment of tele-education

The idea of establishing electronic libraries began towards the end of the 1980s. In 1989 the Japanese Information-Technology Promotion Agency, IPA, designed an electronic "library of the XXI century". The purpose of the tele-education project is to make access to training programmes, as well as to national and international information resources, available from personal computers. In 2000, with cooperation between BSMU and the Medical School of Nagasaki University and with the financial support of WHO/SMHF, this project was successfully initiated and can now be updated locally. The following elements of the tele-education system have been completed:

- installation of the server, its testing and its connection to the local computer network of BSMU;
- extension of the local area network to allow access to remote users;
- extension of the local area network to more than 50 new users;
- installation of four workstations and training of staff to scan books, etc;
- translation into electronic form of all educational materials and software already existing in medical and scientific faculties;
- installation of 30 documents.

Figure 2 shows the distribution of materials installed in the electronic library.

The basic structure of the tele-education system is shown in Figure 3. While BSMU has developed the basic design, the system still needs to be made fully available throughout Belarus.
Figure 2. Percentage distribution of educational materials installed in the electronic library at BSMU

Figure 3. Basic design of tele-education system
2.3 Establishment of an electronic library

The electronic library was established by BSMU to store and search various collections of locally available electronic documents (text, video, etc., especially in Russian), and to access others through telecommunication networks. It was intended for use by medical students and medical specialists. The library can be used for:

- education (reference materials etc);
- support for medical education institutions (educational schedules and working programmes, tutorials, and other educational and methodological issues),
- medical and clinical scientific research.

The primary goal of the medical electronic library – the eLibrary – is to integrate information resources, to upgrade constantly, and to provide an effective search facility for local and remote users. It is important to note that users of the eLibrary are not just BSMU’s employees and students, but anyone requiring medical information from anywhere in the world. Common search engines are available to allow the information to be found efficiently.

Constant upgrade of the eLibrary requires the creation of electronic educational materials, databases and other documents by BSMU, as well as translation of tutorials and monographs into electronic files. For this, preference is given to current reference and educational literature. Books published in foreign languages are added to the library, both in the original languages and as Russian translations.

The eLibrary now contains more than 1.5 Gb of electronic documents, including tutorials, educational programmes and study guides. It also contains more than 100 lectures in PowerPoint format, all of which are available via the Internet, together with useful search facilities for catalogues and references. Students of BSMU have freely used the electronic library to great benefit.

A special textbook on radiation medicine and thyroidology has been prepared as an Internet-based WHO Telematics publication (shown in Figure 4 below). In addition, BSMU has developed the software for an International Telemedicine System as a reference tool to provide real-time interaction among doctors, consultants, experts and others over the Internet. In principal, this allows online consultations. So far, however, the software has not been fully used: the remaining problems will be overcome through a joint project between BSMU and Nagasaki University.

The textbook on radiation medicine and thyroidology covers the topics listed in items 1 and 2 below; item 3 lists the topics covered by another collaborative textbook.

(1) Atlas of thyroid physiology and pathology

- Clinical anatomy
- Histology
- Development
- Cell physiology
- System physiology
- Clinical diagnosis
- Fine needle aspiration biopsy and cytology
- Pathology
- Ultrasound semiotics
- Computerized tomography

(2) Molecular biology of the thyroid gland
• Morphology and clinical anatomy of the thyroid
• Thyroid development
• Cell physiology of the thyroid
• Regulation of thyroid function
• Molecular pathology of thyroid diseases
• Pharmacological regulation of the thyroid
• Ultrasound diagnostics of the thyroid
• Morphological diagnostics of thyroid gland
• Thyroid diseases in childhood
• Autoimmune thyroid diseases
• Thyroid cancer

(3) A guide to molecular diagnosis of human diseases

• Normal blood values
• Critical value
• Core blood chemical analytes
• Urine
• Cardiovascular diseases
• Respiratory diseases
• Gastrointestinal diseases
• Hepatobiliary diseases and diseases of the pancreas
• Central and peripheral nervous system disorders
• Musculoskeletal and joint disorders
• Haematological diseases
• Metabolic and hereditary disorders
• Endocrine diseases
• Infectious diseases
• Disorders due to physical and chemical agents
• Effects of remedies on laboratory test values
• Therapeutic drug monitoring and toxicology

A “supercourse” of lectures on thyroid cancer diagnosis and treatment has also been established jointly by Nagasaki University and BSMU; its home page is shown in Figure 5.
Figure 4. Internet based lectures on thyroid cancer
2.4 Impact of the tele-education project

The tele-education and eLibrary facility should increase the professional competence of medical staff working outside large cities. Information on new diagnostic and treatment technologies should improve the quality of medical care to the population of Belarus. Access to the library is planned for employees and students of the Gomel State Medical University (GSMU) and then for other centres around Belarus.

Telemedicine resources/links applicable to thyroid cancer and available through the eLibrary areas follows:

- Medical Computing Today (MCToday)
  http://www.medicalcomputingtoday.com
  Издание для врачей. Различные аспекты применения компьютеров в практике. Аннотированные ссылки на лучшие ресурсы. Минимум рекламы.

- Kansas Univeristy Center for TeleMedicine and TeleHealth
  http://www2.kumc.edu/telemedicine
  Программа объединяет более 40 консультантов по 15 специальностям. Предоставляет доступ к 20 другим серверам штата Канзас.

- Georgia Statewide Academic and Medical System
  Одна из крупнейших сетей для видеоконференций. Обеспечивает доступ к более чем 400 подобным серверам.

- University of Vermont
  http://www.vtmednet.org/telemedicine/
  Программа для управления здравоохранением и медицинским образованием.
University of Virginia
http://www.telemed.virginia.edu/
Server обеспечивает консультативный сервис как работникам здравоохранения, так и пациентам.

Telemedicine at East Carolina University
Обеспечивает потребности в медицине в сельской местности США, а также показывает ценность телемедицины на военных объектах и в тюрьмах.

Centre of Telemedicine, Uppsala, Sweden
Центр телемедицины в Университете Упсалы, основан в 1997 году. Состоит из консорциума, включающего научных работников, преподавателей и студентов.

The First Large-Scale International Telemedicine Trial to China: Zhu Ling’s Case
10 апреля 1995 года сообщение электронной почты с просьбой о помощи было послано из Пекинского университета в Internet, Студентка ZHU Линг заболела неизвестной тяжелой болезнью. Сообщение получило широкое распространение. Это показало, как стираются границы культурных, языковых и политических барьеров между Китаем и западным миром.

Virtual Hospital
http://vh.org
Виртуальный госпиталь - проект мультимедиа-лаборатории Кафедры радиологии Медицинского колледжа университета штата Айова. Широко известный проект.

Alaska Telemedicine Project
Крупномасштабный проект по внедрению услуг телемедицины на Аляске.

Telemedicine and Health Care Informatics Legal Issues
http://www.netreach.net/~wmanning/telmedov.htm
Компьютеризация здравоохранения порождает массу спорных вопросов в области права. Данная страница посвящена юридическим аспектам телемедицины.

Telemedicine Resources at Mayo Clinic
Используя комбинацию наземной и спутниковой связи, Университет Мао проводит видеоконференции с региональными филиалами.

Open Gates Teletraining Institute
http://www.telemedicine.com
Сервер некоммерческой образовательной организации, разрабатывающей телемедицинское направление в Stillwater, Oklahoma.

Telemedicine Resources
Список ресурсов по телемедицине доступных в Веб.

National Library of Medicine Teleradiology Project
Проект в области новой медицинской технологии - тelerадиологии.

Radiologist.com
Здесь много ссылок для всех, интересующихся тelerадиологией. Теперь доменное имя продается за $ 80 000.
Future of tele-education and telepathology

Technology is advancing ever more rapidly with the result that existing systems need to be periodically updated to take advantage of increased transmission speed and of features that allow clinicians to do more – often at reduced cost. As a matter of the highest priority, the telemedicine facility needs to take advantage of greatly increased data transmission speeds. The tele-education system will also benefit from the following:

- establishment of new and updated teaching modules
- expanding the content of the electronic teaching courses
- Internet publishing of basic and clinical medical textbooks
- development of self-assessment and distant examination software
- development of virtual classes
- establishment of an Internet-based lecture "broadcasting system”.

Telepathology will be enhanced by:

- an updated image processor
- a data filling system
- a database and information security system
- an updated data and image transfer system.

Following staff changes at BSMU, new leadership is needed for the Project; a reorganization of staff and responsibilities is essential to promote the Project activities in BSMU.
3. Gomel Specialized Medical Dispensary

The following equipment was obtained and installed in 2001 at the Gomel Specialized Medical Dispensary (GSMD) – now the Republican Centre for Radiation Medicine and Human Ecology (RCRMHE):

- server, system block Compaq Proliant ML350 – monitor Samtron 76 BDF (1 piece)
- workstation for telepathology, Compaq (2 pieces)
- workstation for teletraining, Compaq (2 pieces)
- microscope, Leica Microsystems type 020-519/011 DMLB 100S – with video camera, Sony XC-003P-3CCD (1 piece)
- modem, MTM20/S/230/V35 (1 piece)
- modem, MTM20/M/230 70 TB (1 piece)
- router, CISCO 2621 (1 piece)
- Switchboard Fast Ethernet Switch, 16-port auto 10/100 Mbps switching model FS516 (1 piece)
- scanner, HP Scan Jet 3300C (1 piece).

The following were also achieved:

- Installation of system software for the server and workstations for providing sessions on telepathology and tele-education.
- Installation of an internal local network for telemedicine and tele-education.
- Installation of switching equipment in GomelOblTelecom; connection of the communication line (64 kbs) between RCRMHE and GomelOblTelecom.
- Technical requirements elaborated for the software, forms for data entry and observation of patients with thyroid diseases, and transferred to BSMU.
- Training provided for medical personnel using the software developed by BSMU for accumulation of a thyroid disease database.
- Installation of switching equipment (Fast Ethernet Media Converter AT-MC103XL – 2 pieces) and fibre-optic communication lines between RCRMHE and GomelOblTelecom.
- Information channel between RRCRMHE and BELCMT made operational, at 64 kbs, in April 2004
4. Gomel State Medical University

4.1 Introduction

Gomel State Medical University (GSMU) participated in the Chernobyl Telemedicine Project according to Order No. 547A of 30 November 2000 of the Ministry of Health. The main aim was to introduce up-to-date information technology (IT) into the academic and research activities of the University and to gain access to current methods in medicine in an effort to ensure the education of future doctors to international standards.

Established only in 1990, GSMU is a young medical university. The basis for its establishment was increased concern about the health of the population living in areas radio-contaminated by the Chernobyl disaster and providing them with appropriate medical care.

At present, the University has five faculties with 2500 students and more than 200 teachers; of its 31 departments, 16 are clinical and situated on the premises of the largest medical institutions in the city. The clinical base of the University is among the best in Belarus, using advanced medical technologies for the diagnosis and treatment of thyroid, cardiac, haematological, ophthalmological, oncological and other diseases.

Most graduates (78%) remain to work in the Gomel region; 20% are allocated to work in the most contaminated territories.

4.2 Realization

The telecommunication network connected 11 participants of the Project in Belarus; GSMU and RCRMHE are located in Gomel while other participants are in Minsk. The basic equipment (server, router, 2 modems, software, scanner, 20 workstations) was received by the University at the end of 2001, and design and development of a corporate network for the Project participants were undertaken. In February 2002 in Minsk, participants were trained – by the BelSoft Company – to work with the network equipment.

The University’s access to the corporate network was made possible through the digital 64-kbs Gomel–Minsk communication channel via the BelCMT server. Modem tools were installed on the premises of the regional communication centre GomelObrTelecom and at GSMU; communication network and modems speed were tested. From July 2002, GSMU was ready to connect to the other Project participants.

The University invested in the development of the local network, purchasing multimedia tools for video conferencing. In June 2002, the University created the Telemedicine Centre, which provides academic, research, medical, inter-university and international activities for the University in IT fields. Some of the computer installations can be seen in the photographs below.
Classes for foreign students are shown in the photographs that follow. The impact of computer-based medical education is greatly appreciated by both lecturers and students.
4.3 Results

Participation of GSMU in the Telemedicine Project has provided valuable new facilities for the educational process in the University and for the training of medical staff in the Gomel region. The Project, supported by WHO and SMHF, has been a powerful force for the development of IT in the educational, scientific and medical activities of the University. More than 200 staff of the University have been taught by the personnel of the Telemedicine Centre to work with computers and multimedia equipment, and the computer rooms of the Centre are used for practical classes, lectures and tests.

More than 150 medical programs were installed on the server of the Centre. An electronic catalogue was created for use by students, teachers and postgraduates of the University as well as by doctors from various medical establishments in Gomel.

All 31 departments of the University developed multimedia lectures in all basic subjects (including in English for foreign students). At present there are 10 multimedia projectors used for lectures and video conferences. The staff of the Telemedicine Centre provide consultative and practical help in the use of multimedia technologies for organizing and conducting educational seminars; workshops are held in the hospitals and dispensaries of Gomel.

Figures 6, 7 and 8 show the increases in computer use and in the numbers of lecturers and science students, respectively, at the University following arrival of the equipment for the Project.

In May 2003, a digital communication channel of 64 kbs was tested and put into operation between the Telemedicine Centre in Gomel and BelCMT in Minsk. Since that time, GSMU has been able to use the channel to access the corporate network of Project participants. The channel has also allowed continuous access to the Internet and provided every staff member and student with an e-mail facility. However, with the limited data transmission speed of only 64 kbs per communication channel, GSMU cannot connect a large number of computers to the Internet: priority access is provided in the Telemedicine Centre and the University’s library.

Access to electronic medical resources worldwide significantly enriches research work at GSMU. Similarly, access to the corporate network and to information resources in tele-education on the BSMU web site and through RSML has contributed enormously to improving the educational process. The BSMU web site has an important electronic library with monographs, lectures, presentations and manuals, used by both students and teachers. Specialists at BSMU developed the national course on thyroidology and radiation medicine, which is available at any time. The lectures and presentations on the GSMU web site may be found at www.meduniver.gomel.by.

In September 2003, specialists from BSMU and GSMU organized a training workshop for teachers, endocrinologists, cytologists, pathologists and paediatricians from the largest medical institutions of Gomel. The agenda included study of software opportunities in telepathology and tele-education. Trainees acquired both theoretical and practical skills in the use of the “International Telemedicine System” computer program.
Figure 6. Number of computers used at GSMU 1998 – 2004

Figure 7. Number of lecturers at GSMU 1998 – 2004

Figure 8. Number of science students at GSMU 1998 – 2004
The possibility of delivering online lectures through the Gomel–Minsk communication channel has been much discussed. Running a high-quality video session would probably require communication channels that provide a minimum data transmission speed of 256 kbs (128 kbs each for video and audio data). The present 64-kbs channel is sufficient only for online lectures but does deliver good sound quality (with no delays) and a satisfactory image; moreover, it is possible to run Windows applications (Word, PowerPoint, WordPad) during the sessions and to share text and graphic files. The use of online multimedia lectures demands that lecturers adapt to delivering material in this new environment. Careful preparation of the material is needed, with optimization of any images used so that they may be reduced in size without loss of clarity.

The first online lecture from Minsk University was delivered by a professor from New York Medical College, with “live” communication between the professor and students in Gomel and Minsk. This was not only the first online lecture for Gomel and Minsk Universities but also the first in Belarus. For the future, regular online lectures run from BSMU and the Belarusian Medical Academy of Postgraduate Study are planned for students and postgraduates of GSMU.

In February 2005, the first video conference session was held, between Nagasaki University and GSMU. For this purpose, the facilities of the international web site (http://www.meetingplaza.com/) of NTT-IT, the Japanese telecommunication and video conferencing company, were used to provide the capacity to send and receive audio and video data. Exchange of audio, video and graphic files was completed successfully; the latest plans include organization of online lectures from Nagasaki University on the anniversary of the Chernobyl accident.

The Telemedicine Centre both facilitates use of materials available on the Internet and designs its own electronic education manuals, in both Russian and English, in collaboration with the Oncology Department of GSMU. The first manuals to be developed are shown in the photographs that follow.
Following the preparation of these education materials, the electronic catalogue of medical information and software, more than 150 resources have been created and are widely used by students. However, when accessing standard communication channels with a data transmission speed of 1.2 Mbs, receiving large amounts of information (e.g. transmission from an operating room) is impossible with the current modem speed of 64 kbs. One solution is the introduction of multimedia techniques in medical education. Electronic manuals for use with contemporary multimedia technologies in the medical fields of greatest interest to students have been created. The surgical manuals provide students with the “live” experience of being in an operating room during surgical procedures, and allow them to observe rare illnesses and conditions with detailed commentary by leading specialists. The initial material – surgical operations, rare conditions, manipulation outcomes, and treatment follow-up of specific cases – is recorded in a special medical environment. The recorded video materials are processed in the Telemedicine Centre, and text, graphic and animation files are then added.

From the eLibrary of BSMU there is access to the tele-education system with the medical training course in thyroidology and radiation medicine. However, a considerable amount of time is spent on voice-transfer. The “live” sound of the operating room is stored to enhance the reliability of the material and is supplemented by a clear commentary. The possibility of post-operative dubbing and supplying materials with appropriate graphics allows the production of high-quality training films with detailed descriptions of the events taking place on screen. This approach allows a more precise study of all surgical details than is possible during online transmission of an operation when a surgeon needs to concentrate on the operation rather than on a commentary to the audience.

Five electronic educational manuals in Oncogynaecological Surgery have been created for fifth- and sixth-year students. These manuals contain both the theory of particular operations and video recordings of surgery performed by doctors of the Oncology Unit; selected images from the manuals are shown in the following illustrations.
Specialists within the Telemedicine Centre have worked to introduce new technologies into the activities of the University and other medical institutions of Gomel, and reports on the potential of the system have been presented at many meetings. These same specialists have also participated in several international research conferences and symposia.

### 4.4 Problems and perspectives

The remaining difficulties in tele-education for GSMU – which are gradually being overcome – are the following:

- Low-speed communication channels, which do not allow transfer of high-quality video and audio information.
- The lack of equipment for, and of experience in, video conferencing.
- The remoteness of educational and clinical bases and the undeveloped computer infrastructure.
- The lack of skill among medical personnel in the sphere of computer technology.

As shown in Figure 9, most of GSMU’s clinical departments are located on the premises of the largest hospitals in Gomel, which are separated by distances of up to 20 km. A project to develop a single network that would unite remote departments with access to the corporate network is therefore under way. Communications between GSMU and Gomel’s medical establishments are being organized using fibre-optic channels with VPN (Virtual Private Network) and ADSL (Asymmetric Digital Subscriber Line) technologies.
Information exchange between departments – through the Centre’s computers and server – and the possibility of using a constantly updated catalogue of materials in all fields of medicine will allow students to benefit from the most modern teaching techniques. Using network connections between departments, doctors may communicate with each other, share graphic and video information, consult doctors from other clinics, and participate in joint forums and video workshops.

Since most of GSMU’s graduates work in the Gomel region, further development of the network may include hospitals situated in areas affected by the Chernobyl accident, where there is a desperate need for modern diagnostic and treatment methods. Introduction of the telecommunication network will facilitate consultation by doctors from the specialized clinics of Gomel and the University without need for the doctors to leave the area. The wireless communication technology that has been installed as a pilot project is shown in the photographs that follow.
4.5 Conclusion

The introduction of telemedicine technologies in the educational process has made a substantial contribution to the training of medical specialists, and the methods have also been used in post-graduation educational and training courses. The available network will allow connection not only of the departments of the University but also of the largest medical establishments in the region. Subsequent introduction of telecommunication technologies at all levels of health care, from polyclinics to scientific laboratories, will allow the health monitoring system to include anyone living in the disaster zone from birth to old age.
5. Future development of telemedicine

5.1 World Health Assembly eHealth resolution

During its 58th meeting in Geneva in May 2005, the World Health Assembly (WHA) adopted an unprecedented resolution (WHA58.28) on “eHealth”. By definition, eHealth is concerned with all the various uses of information and communication technology (ICT) for health purposes, locally or at a distance, including telemedicine. The resolution urges WHO’s 192 Member States to develop their own national eHealth strategies, including technological, administrative and legal issues. In addition, each Member State is urged to establish its own national eHealth centre and to develop interregional or international relationships. WHO has been requested to develop common norms for ethical and legal issues, to develop an ongoing survey of world best practices, and to boost the use of eHealth by means of eLearning courses in health education and training. This political commitment is a crucial mandate for national and international action plans.

5.2 National eHealth action plans

After more than 15 years of research, pilot phases, test beds, conferences, etc., the current status of eHealth in the world is far from uniform. What is certain is that Internet access and the use of mobile telephones are increasing extremely rapidly, even in the less developed countries. Investment and ongoing costs continue to decline, and it is expected that, by 2010, 80% of the world's population will have access to these technologies. Nevertheless, use of ICT for health purposes varies widely among the countries of the world: in many of the G8 countries, national implementation plans have been developed for improving traditional systems of health care delivery. eHealth solutions are expected both to save money and to improve access to, and the quality of, care. The G20 countries, where urgent reform of health systems is critical, support the development of numerous telemedicine initiatives – for a second medical opinion, for eLearning, for continuous training, and for optimal use of scarce human resources. Elsewhere, numerous case-by-case initiatives are promoted by nongovernmental organizations with the support of various United Nations agencies.

5.3 Telemedicine for the management of radiation accidents

The use of eHealth solutions for the management of radiation accidents concerns all facets of the health care system and must be one of the components of national eHealth plans. Management of the crisis in south Asia following the tsunami of December 2004 illustrated that no health actions were possible without telecommunication. Dealing effectively with the health challenges relied on efficient data collection, and transmission, and comprehensive round-the-clock use of the data by competent people in the "situation room". In handling that crisis, WHO HQ and the Regional Office for South-East Asia confirmed what had already become clear during management of SARS (severe acute respiratory syndrome) in 2003 – that eHealth is a fundamental instrument for efficient crisis management.

One of the key components of the action is based on a "targeted population approach during all the phases of the process". Clearly, the main targeted populations are health care professionals and specialists, but professionals from other fields (fire services, civil protection, police, etc) and the general public must be integrated into the overall system from the beginning.

During the event, a clear methodology for communication and coordination of the actions proposed by the situation room personnel is needed. It is critical that
relations with the media (television, radio, etc.) be especially clear and transparent. Satellite access and mobile telecommunications are important, particularly in the early stages of a crisis. Independent telecommunications facilities that have their own sources of power are extremely useful when other ICT channels have been destroyed.

After the event, a long-term comprehensive public information strategy (involving web sites, information centre, call centres) is essential.

Other key issues are:

– a robust infrastructure including satellite access,
– a competent telecommunications team, and
– international cooperation and networking with specialists.

### 5.4 Telemedicine for remote area training and support

Particular attention should be paid to the training of two sensitive targeted populations – health care professionals and the general population. With the exception of a few specialists, health professionals are not kept up-to-date with the management of a radiation crisis, yet they are in the front line, faced with the demands of an anxious population. Plans are thus needed for appropriate education in addition to the normal academic training of these professionals.

Many useful radioprotection courses already exist on the Internet. It is the responsibility of national health authorities to guarantee the accessibility of appropriate and up-to-date courses for doctors. Ideally, all health care professionals should have their own access to ICT facilities, via computer or mobile telephone. eHealth medical platforms can be developed for many purposes, including second medical opinions and specific specialist advice in respect of confidentiality and security of medical data. These facilities are valuable not just in times of crisis but also before and afterwards. It is crucial that the general medical requirements are adapted to specific local circumstances and make use of local language(s). A specific national or regional secure intranet service for health care professionals would be welcome.

For the general public, the absence of clear and comprehensive information results in additional stress in a crisis and could lead to panic. During the outbreak of SARS, the WHO web site made up-to-date information available worldwide as soon as data had been collected and verified. This proactive approach was particularly appreciated in affected countries (Canada, Thailand, Viet Nam, etc.); the web site received 10 million “hits” and was considered to be a powerful instrument for allaying fears and countering other problems thrown up by the outbreak.

In such a context, rapid response is critical: every hour counts. A large public web site or an automatic mobile service is needed within the first few hours following the outbreak of a crisis. This need must be anticipated, and IT and health professionals should be trained to work together as rapidly as possible. A question-and-answer service could be established to respond to the concerns of the general public.

### 5.5 Potential linkages with the European Union and other programmes

For the management of a massive radiological crisis, the principal issues concerning international cooperation with the European Union (EU) and others are the research and action plan programmes.
International cooperation has been boosted by the advent of bioterrorism. Since 11 September 2001, numerous international systems have been put in place for this specific purpose. Web-based eLearning facilities for health care professionals and the general public are expanding and are extremely powerful. However, it is essential that criteria for the quality of health-related web sites are respected. To check the quality of these sites, the European Commission (EC) has approved a communication entitled *Quality criteria for health-related web sites*. These criteria are implemented by Health On the Net Foundation (HON) – a non-profit organization based in Geneva – and accredited web sites are marked with a special logo.

In the area of research, both medical and basic, the powerful concept of "networks of excellence" made up of first-class medical or research centres has recently been promoted by the EC, with the eHealth networks as the basic instruments. The development of “grids” technologies, promoted by CERN (European Organization for Nuclear Research) with the support of EC research programmes, offers further potential. The European Health Grid network has already demonstrated the benefits of this distributed technology for merging disseminated and heterogeneous medical and biological databanks, for analysis of multidimensional molecules or cell structures, and for complex mathematical processes. The extensive experience and expertise of the Belarusian telemedicine network marks it out as a candidate to join or lead an "excellence centre network" focused on the health effects of ionizing radiation.

### 5.6 Extension to other countries in the region

International partnerships are a component of the WHA resolution on eHealth – and crucial for optimizing the use of technical resources, for economy, for security and for efficiency. WHO's Member States are urged to develop eHealth partnerships as well as to formulate their own national plans. Within the EU, the EC supports cross-border “exchange” of patients; outside the EU, it supports international cooperation. The Euroniemen initiative, supported by the EU Phare/Tacis programme and managed by Poland, is an example of cooperation between countries in the region, including Belarus, Estonia, Latvia and Ukraine; there are plans for greater active collaboration in research, development, education and continuous training. In addition, some countries of the former Soviet Union, such as Kazakhstan, have already developed strategic telemedicine initiatives. Strong political will has been demonstrated, especially for the use of satellite communication facilities. In this area, the WHO Regional Office for Europe, (Copenhagen) can play a proactive role: the necessary human resources exist and regional action plans can be prepared in response to the demands of Member States.

### 5.7 Conclusion

Telemedicine and eHealth are not just an option for the future: WHO eHealth solutions are both the basis for restructuring of existing health care delivery systems and an instrument for the implementation of public health regulations.
6. Activities after completion of the Telemedicine Project

The following comments were made by a mission from Nagasaki University that visited Belarus in January 2005 to follow up the WHO/SMHF Chernobyl Telemedicine Project:

- The Ministry of Health had a budget of 30 000 000 roubles (US$ 14 000) in 2004 for communication expenses but spent much less. Unfortunately, access by end-users of software and systems developed at BSMU has been cut because the communication channels are currently disconnected. In this regard, a letter has been sent from BelCMT to BSMU, but no reply has been received.

- There are two communication channels between Minsk and Gomel, one for GSMU and the other for the Gomel Specialized Medical Dispensary (now RCRMHE). The data transmission speed of 64 kbs is sufficient for this purpose but not for video conferencing or for telepathology and tele-education. Currently, BelCMT has plans to increase the speed to 256 kbs.

- Distance-learning programmes began in October 2004 between GSMU and BSMU: GSMU noted that the service was running very well. Demonstrations of the educational software have been held by BSMU.

- Unfortunately, since its inception in 2004, little practical use has been made of the telepathology service developed by BSMU. However, the Gomel Specialized Medical Dispensary wants to extend the use of the service to pathologies other than of the thyroid.

- Since the start of the Project, a software replacement has been proposed but would cost US$ 2000 dollars.

Several problems remain to be solved but slow and steady expansion of telemedicine is promising, especially in the Gomel region. For further development of the Chernobyl Telemedicine Project, it is planned to strengthen multichannel networks within Belarus. Ideally, linkage with international academic and research projects, such as the Chernobyl Tissue Bank project, would improve the review of the pathology of thyroid cancers. Improvements to the local network system for teleconsultation in the Gomel region are under construction. The leading role of GSMU is greatly appreciated.

Accordingly, reports have been compiled and have been evaluated by BelCMT, BSMU, GSMU and GSMU. Strategic planning for the future development of telemedicine is based on the WHO eHealth project.
Further reading


Annex 1

Members and contributors

Management Committee
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Sustainable Development and Healthy Environments
World Health Organization

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Chair of the Board
Sasakawa Memorial Health Foundation

Dr Igor Zelenkevitch
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Ministers of Health of the Republic of Belarus during implementation of the Project

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Republican Republican Research Centre for Radiation Medicine and Human Ecology
Gomel State Medical University
Belarusian State Medical University
Belarusian Centre for Medical Technologies
### Annex 2

#### List of donated equipment

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Quantity</th>
<th>Total cost (US$)</th>
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<tr>
<td>1</td>
<td>Router, Cisco Mid Performance Dual 10/100 Ethernet Router w/Cisco IOS IP, Cisco Systems</td>
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<td>PO Cisco 2600 Series IOS IP/FW/IDS plus IPSEC 3DES</td>
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<td>Module 32 MB DIMM DRAM for the Cisco 2600XM</td>
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<td>Module Cisco 2-Port Serial WAN Interface Card spare, Cisco Systems</td>
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<td>Cable Cisco V.35 Cable, DTE Male to Smart Serial, 10 feet, Cisco Systems</td>
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<td>6</td>
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<td>7</td>
<td>Modern JIEC MM-31, 1 port G.703 co-directional, 1 port V.35, power supply 220B, RB</td>
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<td>8</td>
<td>Connecting cable Patch Cord Cat. 5 10 m, Russian Federation</td>
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<td>Connecting cable Patch Cord Cat. 5 1 m, jumper, Russian Federation</td>
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<td><strong>Passive equipment</strong></td>
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<td></td>
<td><strong>Optic boxes and sockets</strong></td>
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<tr>
<td>1</td>
<td>Optic boxes 19&quot; to 16 cut-off point ST; with pull-out shelf</td>
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<td>2</td>
<td>Short-cut universal socket</td>
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<td>3</td>
<td>Set of earth wires (for optic sockets)</td>
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<td><strong>Accessories for assembling of optics</strong></td>
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<td>Splice cassette for K3CO AMP</td>
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<td>Cover for the splice cassette AMP</td>
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<td>Holder for 6 KZCO (less than 3 mm) AMP</td>
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<td>5</td>
<td>Cylinder KDZC (protective socket for welded junction)</td>
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<td>Steel perforating tape, 10 m</td>
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<tr>
<td>4</td>
<td>Microscope set (eyepiece and framegrabber)</td>
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### Annex 3

**Financial summary**

<table>
<thead>
<tr>
<th>Items</th>
<th>Budget (US$)</th>
<th>Funds spent or committed (US$)</th>
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<td>Training and software</td>
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<tr>
<td>Management, coordination, travel and miscellaneous expenses</td>
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<tr>
<td>(Publication)</td>
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<td>10 000 (earmarked for final report)</td>
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<td>WHO programme support costs</td>
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