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Nucleating the development of telemedicine to support healthcare workers in resource-limited settings: a new approach

Richard Wootton[1,2], Wei-I Wu[3] and Laurent Bonnardot[4,5]

Summary

Collegium Telemedicus (CT) offers a new approach to the problem of starting a store-and-forward telemedicine network for use in low resource settings. The CT organization provides a no-cost template to allow groups to start a network without delay, together with a peer-support environment for those operating the networks. A new group needs only to supply a Guarantor (who accepts responsibility for the work of the network) and a Coordinator (who operates the telemedicine network, allocating cases and ensuring that they are responded to). Communication takes place via secure messaging, which has several advantages over plain email, e.g. all the data are stored centrally, which means that they can be read from a hand-held device such as a smart phone, but do not need to be stored on that device. Users can access the system with a standard web browser. In the first three months, seven networks were established on the CT system by university groups in the US, the UK, Australia and New Zealand, and by a large, multinational humanitarian organisation. In the most active network, there were 86 telemedicine cases in the first three months, i.e. an average submission rate of 7 cases/week. The CT system appears to fulfil its aim of assisting doctors who wish to help colleagues in other countries by improving their access to specialist opinions, while allowing them to maintain control over the new network's use and development. The long term aim of the CT organization is to provide a means of improving the quality of health care at the point of delivery in low resource settings.

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Introduction

It is not uncommon that individuals or organizations wish to support doctors working in remote or low-resource settings. A common scenario is that one or more doctors visit colleagues in a developing country, usually to conduct teaching and training. Recognising the difficulties of obtaining specialist opinions there, they offer to support their colleagues by email on their return. Email support is duly provided, but proves to be not entirely satisfactory, e.g. because of confidentiality concerns, difficulties in organising the right person to respond to requests and the absence of an audit trail. Establishing a formal telemedicine network is then considered, the options being to join an existing network, or to start one from scratch, either using existing software or building the software required.

Existing networks

A number of telemedicine networks supporting work in developing countries have arisen over the years; a recent survey identified nine which have operated for periods of 5-15 years.[1] Some networks, such as that operated by the US military in the Pacific, are tightly constrained in their remit, and it would not be practicable for outside organizations to join and make use of their services. Generally speaking, these networks have evolved to suit the region, the language group and the ethos of the sponsoring organization that they serve. For example, the RAFT network provides educational (and some clinical) services by telemedicine, mainly in French-speaking Africa.[2] Small groups of doctors wishing to support a limited number of colleagues in a particular location may therefore find existing networks unsuitable for their purpose.

Starting a network with existing software

An early attempt to provide software suitable for telemedicine work in developing countries was the

[1]Norwegian Centre for Integrated Care and Telemedicine, University Hospital of North Norway, Tromsø, Norway
[2]Faculty of Health Sciences, University of Tromsø, Tromsø, Norway
[3]Centre for Online Health, University of Queensland, Brisbane, Australia
[4]Department of Medical Ethics and Legal Medicine, Paris Descartes University, Paris, France
[5]Fondation Médecins Sans Frontières, Paris, France

Corresponding author:
Professor R Wootton, Norwegian Centre for Integrated Care and Telemedicine, University Hospital of North Norway, PO Box 6060, 9038 Tromsø, Norway.
Email: r_wootton@pobox.com

TeleMedMail program from MIT.[3] The software can still be downloaded from the Internet. However, there do not appear to be any well-publicised examples of its use. More recently, the software for the SANA mobile phone system has been made available.[4]

The best example of freely-available telemedicine software is the iPath program. This provides a web platform for case-based collaboration – it was originally designed to facilitate discussions amongst pathologists, using a medical Bulletin Board approach. As well as its use in telepathology, the software has been used by several telemedicine groups.[5] The iPath software can also be downloaded from the Internet, but requires significant technical expertise to install.

Building the software required

Building the necessary software for a telemedicine network is perfectly possible, but requires appropriate technical expertise. This approach is also likely to take some time, as a prototype system will need to be fine-tuned in the light of experience.

Whether existing software or bespoke software is employed, an underlying IT infrastructure will also be required, e.g. a web server.

Aim

The present work was undertaken to investigate the feasibility of a new approach to the problem of starting a store-and-forward telemedicine network for use in low resource settings.

Methods

Collegium Telemedicus (CT) offers a cloud-based computing approach to the problem of setting up a store-and-forward telemedicine network. It provides a no-cost template to allow networks to be started without delay. If the network subsequently fails, there is no financial loss to those involved. (And telemedicine networks often fail to survive the initial phase). As activity grows, it is envisaged that a successful network would ultimately move onto a standalone system of its own.

Under the CT model, everything is provided, including the software and a secure web site. A new group wishing to establish a network needs only to supply a Guarantor and a Coordinator. The Guarantor is the person who takes responsibility for the work of the network, specifically warranting that it conforms to the conditions of use (see below). The Coordinator is the person who operates the telemedicine network, allocating cases and ensuring that they are responded to.

The CT system was written using open source software: PHP for the web interface, supported by a mySQL database. Proprietary software was used to write the Help documentation (HelpNDoc, IBE Software). Security was enhanced by using SSL access to the web pages (https:) and by protecting the database with a hardware firewall.

Method of operation

The aim of the CT system is to assist doctors who wish to help their colleagues in other countries by improving their access to specialist opinions; the chosen mechanism addresses problems such as confidentiality through the use of a secure server, while allowing them to maintain control over the new network's use and development. To do this, CT establishes an account for the network Coordinator to use. The Coordinator can then set up accounts for doctors to refer cases, and accounts for specialists to respond to them. The Coordinator is responsible for choosing which specialist(s) should respond to a particular case.

All the required software is provided, accessible through a standard web browser. Thus to start a new network using the CT server, the following are needed:

- a group leader, who assumes overall managerial responsibility for the group. This person acts as the Guarantor, to confirm that the group is operating in accordance with the conditions of use
- a network Coordinator to manage the referrals (who may be the same person as the group leader)
- one or more referring doctors
- access to specialists who will respond to telemedicine queries from the referrers.

Those proposing a new network are required to submit a short prospectus, explaining the basic ideas about the network. The information should include the name of the network, brief details about the doctors likely to be involved and the expected nature of the cases, and some information about the network Guarantor and the Coordinator. If the prospectus is acceptable, the Guarantor and the Coordinator will be asked to complete a web-based registration form; they must also agree to the conditions of use. Once both Guarantor and Coordinator have completed their registration, user accounts are created for them. The Guarantor has full access to the data on the server, but cannot send messages or allocate cases. The Coordinator also has full access to the data on the server, but in addition can send messages and allocate cases.

Secure messaging

The CT system uses secure messaging, rather than plain email. Users need to have an account on the secure messaging platform, which is created for them by a person higher in the management hierarchy (i.e. a Referrer or a Specialist account can be created by the network Coordinator; a Coordinator account must be created by a member of the CT Steering Group). Users can log into their accounts only by typing in a unique username

and password. Messages are encrypted bidirectionally and are stored on the server; they are only available to the user via a secure SSL connection. When a user is contacted for the first time, a one-time password is used to authenticate the recipient.

Secure messaging has several advantages over plain email. For example, all the data are stored centrally, which means that they can be read from a hand-held device such as a smart phone, but do not need to be stored on that device. The approach also provides an audit trail in cases of subsequent medicolegal concerns. However, use of a central server creates a single point of failure, and represents an information source which is potentially vulnerable to hacking.

The CT system was made available in March 2013. No attempt was made to advertise it beyond the immediate circle of the authors.

Results

At the time of writing, the CT system is being used by a total of seven networks, established by university groups in the US, the UK, Australia and New Zealand, and a large, multinational humanitarian organisation. The numbers of networks and the numbers of cases are shown in Table 1 for the first three months of operation.

In the most active network, there were 86 cases in the first three months, i.e. an average submission rate of 7 cases/week. The median delay between a case being received and the first response from a specialist was 9 hours (interquartile range 3-29). For the 86 cases, 107 specialist responses were solicited. The most common categories were radiology (35%), followed by internal medicine (26%) and paediatrics (23%), see Figure 1.

Table 1. Collegium system usage for the first three months.

Network ID	Start date	Total no of users[1]	Total no of cases[2]
9	26 Nov 2012[3]	4	1
11	25 Mar 2013	187	7
12	26 Mar 2013	380	86
13	26 Mar 2013	81	1
14	25 Apr 2013	18	7
17	14 May 2013	6	–
18	14 Jun 2013	22	–

[1]active users only.
[2]all cases, patient-related and test.
[3]date of initial software development.

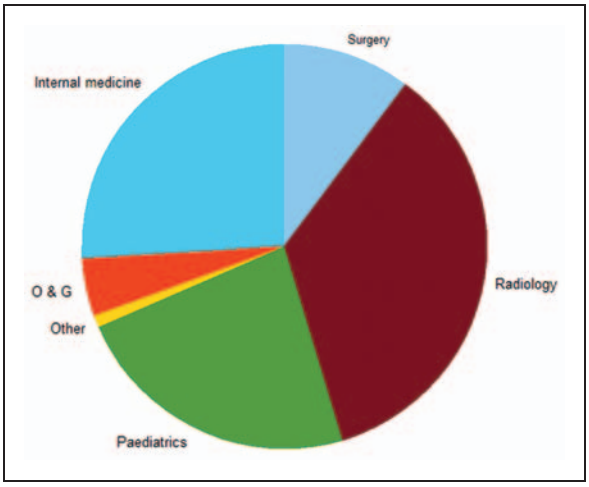

Figure 1. Types of specialists responding to queries during the first three months on one network (n=107).

Discussion

In low resource settings, there is a general lack of specialists, and consequently poor access to specialist care for the population. In addition, physicians often find it difficult to obtain specialised medical education. Improving access to specialist advice is therefore a way of improving the quality of health care at the point of delivery.[6] This can be done through telemedicine, and several long-running networks exist for this purpose.[1] Although successful, these networks probably meet only a tiny fraction of the potential demand. More telemedicine therefore seems desirable.

Although increasing telemedicine activity may be desirable, there are several practical problems about doing so. A review by the World Health Organization (WHO)[7] identified various barriers to realizing the promise of telemedicine in developing countries, including:

1. inadequate infrastructure, including poor connectivity and lack of interoperability standards
2. cost
3. lack of local skills
4. sociocultural differences between sites.

The CT approach is not a panacea, but it can assist with overcoming some of these obstacles. It depends on an Internet-connected device, which can run a standard web browser. Although the infrastructure required is not negligible, it is increasingly available in many resource-limited settings.

Allocation modes

The CT system allows one-to-one and one-to-many case allocation. That is, a new case can be sent to a specific individual specialist for response, or to a group of specialists, as desired by the network Coordinator. Each technique has its advantages and disadvantages, see Table 2. Clearly a system which does not force the Coordinator to choose one or other approach is preferable.

Internationalization

The CT software is internationalized, i.e. to support a new language it is only necessary to translate a single table

Table 2. Advantages and disadvantages with case allocation to a specific expert or to a group of experts.

	One-to-one	One-to-many
Advantages	1. The minimum number of specialists are contacted in order to answer a case 2. Better engagement of the expert	1. Time to first response is faster
Disadvantages	1. Time to first response may be slower, e.g. if the first specialist does not respond and another one has to be contacted	1. Multiple specialists are contacted for each case, running the risk of "responder fatigue" 2. Individual specialists may not feel directly concerned (and assume that a response will be provided by somebody else)

containing the relevant words. The initial version of the CT system was made available in English, French and Spanish. Although the programming makes it easy to add new languages, they have to be L-to-R languages: this approach will not work for R-to-L languages, such as Arabic. To accommodate both L-to-R and R-to-L languages requires specific versions of all web pages to be constructed, see for example the WHO pages (Figure 2).

Coordinator support

A simple Bulletin Board system is available for Coordinator self-help. In principle, cross-network management of difficult cases would be possible, by prior agreement between the network Coordinators.[8]

Other relevant work

The iPath software, although developed originally for one-to-many pathology discussion groups, has many similarities to the CT system and pre-dated it by at least a decade.[9] However, the CT system is not designed for telepathology, and is principally intended for one-to-one general telemedicine work. In many ways it complements the iPath approach, which represented a pioneering step in this form of telemedicine and has proved to be very successful. In the CT system, new networks can be established very rapidly, and the users require no software other than a standard web browser.

Usage in first three months

Data from one of the networks shows that the CT system is realising its aim of improving access to specialists. Multiple cases have been submitted by referrers, suggesting that they find the service useful. The response time (delay between a case being received and the first response from a specialist) was as fast, or possibly faster, than the published response times from similar networks.[10]

The long-term aim is to demonstrate that access to specialized medicine at the point of delivery can improve the quality of heath care in low resource systems. By encouraging the creation of specialist networks and providing full data storage of their activity, CT participates in the mandatory evaluation process (of their real impact in terms of quality of health care). Its no-cost approach is ethically sound, since the benefit of such systems for the patient still needs to be proved (although there is no doubt about the benefits to doctors in terms of education), and it helps to avoid failure at the critical initial phase, a stage when many telemedicine networks fail.

Sustainability

The CT system was developed by a Steering Group (the authors) and is maintained and administered by the same group. Operation of the system requires certain resources, such as a secure web server and suitable software. Now that this infrastructure is in place, the system running costs are relatively modest. Starting a new network requires some input from the Steering Group, but once the network Guarantor and Coordinator have been authorised, the subsequent operation of that network is delegated entirely to the Coordinator. We believe that this is a sustainable model while web hosting costs remain low.

Conditions of use

The Steering Group cannot provide guarantees about the quality of medical expertise supplied in a given network. Therefore networks must agree to certain conditions of use (see Appendix). These are intended to avoid ethical and legal problems, and to explain that the CT service is provided on the basis of best endeavour. Each set of network operators needs a contingency plan to deal with potential situations, such as specialist advice not being given due to a temporary system failure and resulting in injury to the patient. (An obvious measure is not to use a store-and-forward network of this kind for life-threatening emergencies).

Conclusion

Collegium Telemedicus offers a new approach to the problem of starting a store-and-forward telemedicine network

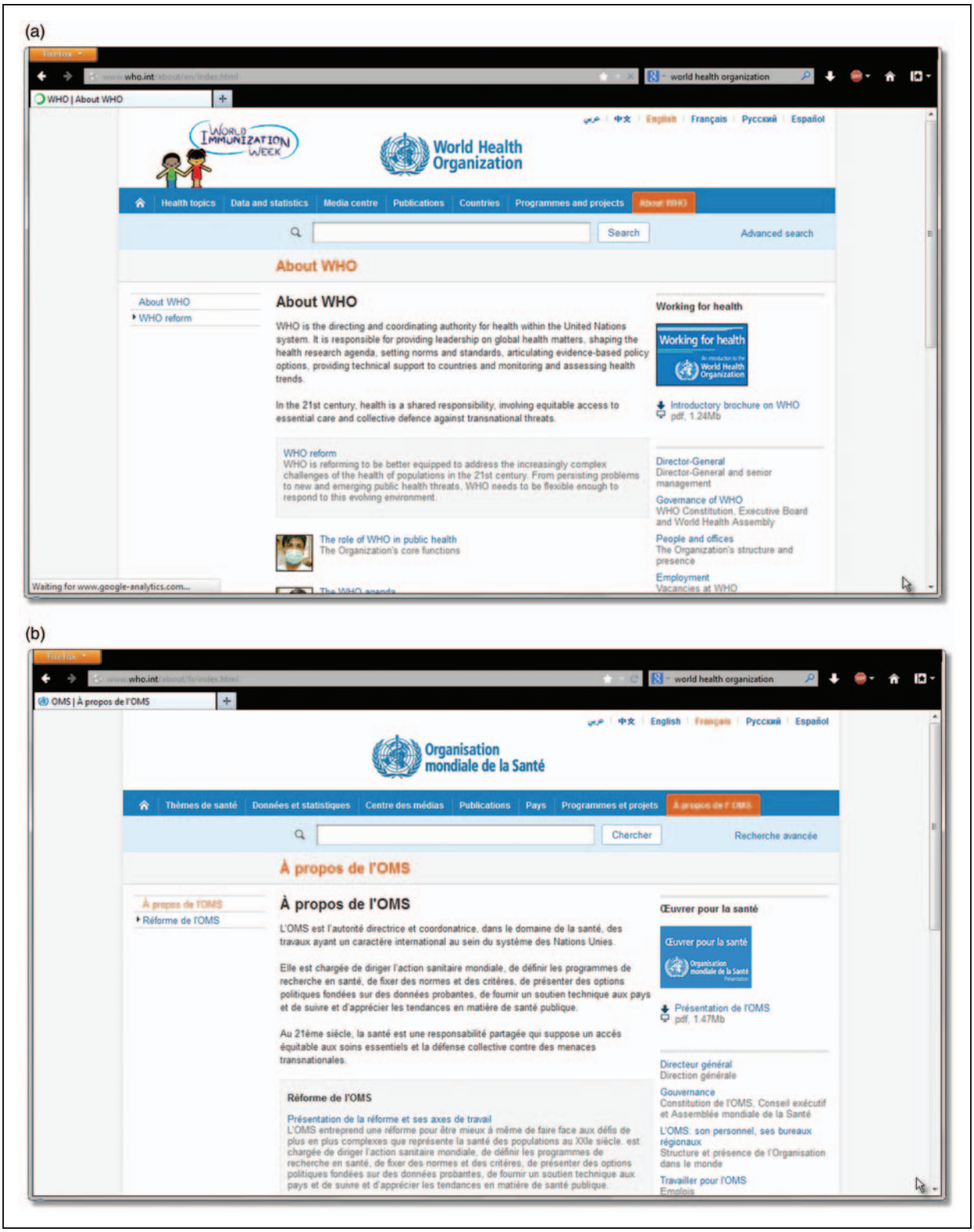

Figure 2. WHO web pages in three L-to-R and one R-to-L language (a). English (b). French (c). Spanish (d). Arabic.

for use in low resource settings. The aim is to assist doctors who wish to help their colleagues abroad, by providing a network template which can be used without technical expertise. The system addresses problems such as confidentiality through the use of a secure server, while allowing groups to maintain control over the new network's use and development. The initial use of the CT system has been encouraging.

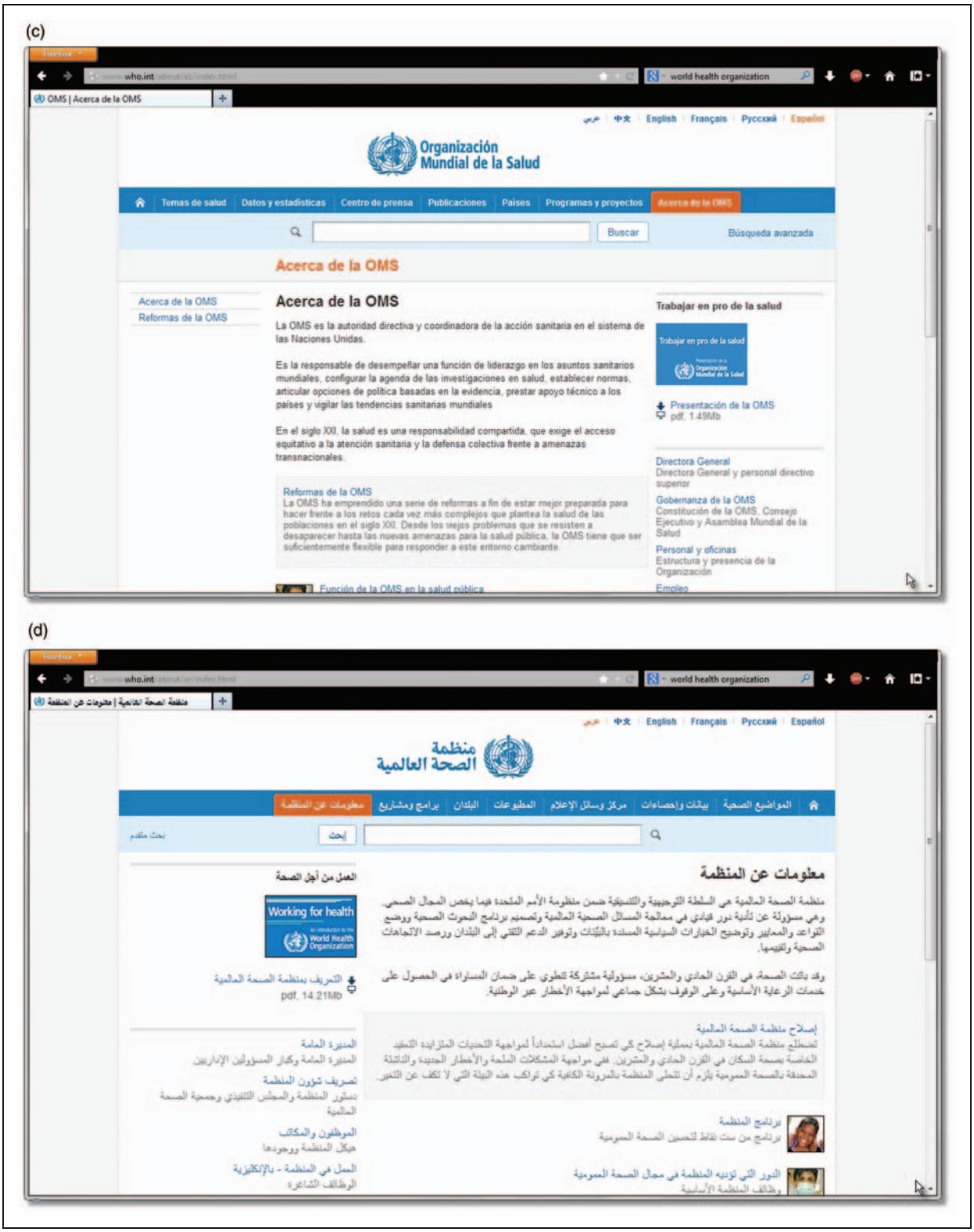

Figure 2. Continued.

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Appendix. Conditions of use

The Collegium Telemedicus (CT) system is made available to facilitate the delivery of health care in remote or low resource settings.

1. The system is provided at the users' own risk, and no responsibility/liability is accepted by the CT organization itself;
2. CT cannot provide any guarantee about the quality of the clinical advice provided through the system, its suitability for purpose, nor the speed with which it is supplied;
3. Any clinical advice is provided to the treating doctor under the normal rules of inter-professional dialogue;
4. Any clinical advice is provided [by the specialist concerned] on the basis of the best information available at the time;
5. Clinical advice is provided on the understanding that the treating doctor is delivering a service to patients on a not-for-profit basis. Because experts in the CT system give their time and expertise for free, we expect the treating doctor to do the same, i.e. not to charge an additional fee for specialized consultations via telemedicine;
6. Users of the system agree to keep patient information confidential, in accordance with normal procedures for medical consultation. Specifically, information may not be used for teaching purposes or published in any other way or transferred to any third party without the prior agreement of CT and the patient concerned;
7. Users must ensure that CT is acknowledged in any publications relying on the work; unless there are exceptional circumstances, CT expects to be informed prior to material being submitted for publication;
8. Users of the system, particularly network coordinators, agree to assist other users in other networks where possible.