Teledermatology in Arctic Greenland

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Providing health care in Greenland is a major challenge (1). Spanning 2,600 km from north to south, and 1,050 km from east to west, Greenland is the largest island in the world (1). In addition, Greenland has the lowest population density on the globe. The population totals 57,000 inhabitants, living in small cities and villages along the coastline, as the inner part of Greenland is covered with a permanent ice cap. There are 18 small cities and 120 small villages. No roads exist between these cities, and travelling between cities requires transportation by helicopter, airplane, boat, snowmobile or dogsled (1).

The weather conditions in Greenland can be extreme (1). Most of the country is located north of the Arctic Circle, and due to the Arctic climate, temperatures regularly fall to –30 to –40°C, and can even drop to –70°C in the coldest places. Besides the cold, Arctic storms, gale winds, heavy fog, and snowstorms can complicate traveling from one city to another.

The Greenlandic Healthcare System

The Greenlandic healthcare system is a public healthcare system which offers free medical treatment and free medication to all Greenlandic citizens. The healthcare system includes physician-staffed local hospitals in 13 cities, regional hospitals in the 4 largest cities Sisimiut, Ilulissat (Fig. 1), Qaqortoq and Aasiaat, and the national Queen Ingrid Hospital in the capital city Nuuk. Patients are referred from local hospitals to regional hospitals, and the Queen Ingrid Hospital serves as the referral hospital for the country. There are 48 rural health care clinics in the small villages, which are staffed by a nurse or health care worker. These rural health care clinics refer to and consult with the local and regional hospitals daily by using the telemedical service 'Pipaluk' (Fig. 2). The Pipaluk telemedical machine enables the nurse or health care worker in the rural health clinic to send electrocardiograms, clinical photographs, otoscopic images, dermatoscopic images, stethoscopic sound files and live video transmissions to local and regional hospitals. In case of emergency or trauma, the physician on call initiates evacuation of the patient by helicopter, airplane, boat, or snowmobile, depending on the level of illness of the patient and the weather conditions.

Physicians working at the local and general hospitals are generalists, most often specialists in general practice, surgery, obstetrics/gynaecology or medicine. For elective consultations, medical specialists travel through the country visiting the regional hospitals and physician-staffed clinics, often once or twice a year. This includes visits from consultants in dermatology, ophthalmology, neurology, otolaryngology, paediatrics, psychiatry, internal medicine, cardiology, surgery, orthopaedic surgery and obstetrics and gynaecology. During these visits, which last around 1–2 weeks, the specialists consult, diagnose, treat and operate patients.

Fig. 1. The hospital in Ilulissat.

The visits by consultants reduce transportation costs within the Greenlandic healthcare system. It is more cost-effective to bring the specialist to the patients, instead of financing transportation for all patients from remote Greenlandic villages to the centrally located specialist. In emergency cases with acute medical or surgical illness, which requires specialized care, the patients are transferred to an appropriate referral hospital either at

Fig. 2. The telemedicine device Pipaluk.

the Queen Ingrid Hospital in Nuuk, or a University Hospital in Copenhagen, Denmark.

Telemedicine

In addition to using telemedicine for the provision of general health care in rural villages, various other telemedical programs have been implemented in the last decade in Greenland. These programs can either be store-and-send applications or live-video-transmissions (2). For ophthalmological cases, there are store-and-forward programs using advanced equipment including optical coherence tomography (OCT) and retina imaging. There are also live-video-transmission programs for psychiatry, including consultations for acute psychiatric problems, as well as other programs for neurology, cardiology, rheumatology, gastroenterology, and wound treatment.

Teledermatology

The first specialty to apply telemedicine in Greenland was dermatology. For this purpose the Pipaluk machine was used. The Pipaluk machine, which is located in all health care facilities across Greenland, is equipped with a regular camera and a camera with an integrated dermoscope. When local doctor was consulted by a patient with a dermatological issue, the local physician could easily seek specialist advice from a dermatological consultant.

The local doctor took clinical photographs with the camera and/or dermoscope, and sent the photos accompanied by a case story via the Pipaluk system to the department of dermatology at Copenhagen University Hospital, Bispebjerg, Denmark. There, a consultant dermatologist reviewed the case and photographs, and replied with advice regarding further diagnostic testing or treatment options. The local physician informed the patient and started diagnostic investigation or treatment as indicated. The local doctor could store-and-send follow-up pictures when required. All cases including the photographs/dermoscopic images were stored in the patients' electronical records.

In addition to the store-and-forward option, live-video transmission with the dermatologist is also possible (2). This option is usually applied when the store-and-forward option does not provide the information needed, for example in cases with diagnostic difficulties, or if the patient does not respond to the initiated treatment. In rare cases, patients are transferred to the department of dermatology at Bispebjerg Hospital. This happens in cases with very severe dermatological disease, in which highly specialized knowledge and intensive treatment is required.

After implementation of a national electronic patient journal Cosmic® in 2017, the procedure for the store-and-forward option was slightly changed. The images are now stored in the electronic patient journal, and the consultant dermatologist has access to the electronic patient journal. This also means that the consultant dermatologist has access to more information, for example laboratory tests.

Advantages and limitations

Teledermatology offers the great advantage that specialized dermatological consultations are available throughout the year. Before teledermatology, patients waited up to one year for the dermatologist visit at the local/regional hospital. A further advantage is that photographs are stored and can be reviewed when necessary.

The teledermatological approach has also limitations. Typically, the clinical information in the case story accompanying the photographs was limited when the Pipaluk model was used, and the dermatologist often lacked important information. This was improved when images where stored-and forwarded in the electronic patient journal, and the dermatologist got access to the electronic patient journal. This could possibly be improved further by using standard schemes containing questions which the local doctor must fill out.

The diagnosis of melanoma skin cancer using teledermatology is difficult, and often the diagnosis cannot be confirmed or rejected based on one teledermatological image only. Hence, the dermatologists at Bispebjerg Hospital are cautious when evaluating teledermatological cases possibly representing melanoma skin cancer. Fortunately, the incidence of melanoma skin cancer is low among Greenlandic Inuits (3).

There are issues with compliance and follow-up with the current teledermatological model in Greenland. Advice given by the dermatologist is not always followed by the patients and health care professionals. Many patients stop treatment once they experience improvement or when they run out of medication. This may lead to a high number of incomplete treatment courses and early disease recurrence. Proper follow-up is possible with teledermatology, and should be aimed for in Greenland to improve (long-term) results.

After the implementation of telemedicine, the frequency of consultations of medical specialists who travel through the country visiting the regional hospitals and physician-staffed clinics has significantly been reduced for some specialties. Visits by psychiatrists have largely been replaced by telepsychiatric consultations. Visits by neurologists have completely been replaced by teleneurological consultations. Also, visits by dermatologists have been reduced from annual visits to all cities to visits every second year to the largest cities, and might be further reduced in the future.

Discussion

Teledermatology is also applied in other areas where geographical distances are large and population density is low (4–6). An example is Australia, where a large teledermatology program is successfully running (4). Other examples are rural Brasil and Afghanistan (5, 6).

Telemedicine should not just be considered as a technological advancement, but as a clinical intervention with potential benefits and harms compared to conventional consultations. A randomized trial showed that teledermatology was safe and had similar clinical outcomes compared with conventional treatment in an outpatient clinic (7). The study also showed that teledermatology was not cost-effective in large cities due to the extra time required for consultations, but when distances between the patients and dermatological clinics are large and travel costs high, teledermatology is cost-effective (7). This is certainly the case for Greenland. In addition, studies have shown that teledermatology is reliable, as high levels of agreement exist between diagnoses made using teledermatology and conventional consultations (8). In addition, recommendations for biopsy in dermatological lesions were comparable between cases seen teledermatologically and by conventional consultations (8).

Studies have also shown that by using teledermatology, dermatologists can supervise general practitioners in performing safe surgery with appropriate margins for diseases like malignant melanoma and other skin cancers (9). This approach of telemedical-directed surgical care significantly reduces travel costs (8). This can also be a useful tool in Greenland, although the incidence of melanoma and skin cancer is low (3).

In addition, store-and-forward teledermatology has been shown to significantly improve the dermatological knowledge of general practitioners using teledermatology (10).

As technological progress continues, new applications of teledermatology have and will become available, for example using mobile phones for teledermatology. These options should be evaluated for the Greenlandic healthcare system, and may be applied in the future (11).

Conclusion

Teledermatology can be a valuable tool for diagnosis and treatment of dermatological patients in areas with large geographical distances, extreme weather conditions, and low population density, like Greenland. Teledermatology ensures the possibility of year-round access to expert dermatological knowledge. Further improvement in compliance, follow-up, and new applications for teledermatology in Greenland should be explored.

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