

Cardiovascular disease (CVD) in the Norwegian Arctic. Air ambulance operations 1999–2009 and future challenges in the region

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ABSTRACT

Background. Air ambulance operations in the Arctic have to deal with remote locations, long distances, rough weather conditions, seasonable darkness, and almost no alternative for landing. Despite these challenges, people expect high quality, specialist health care.

Objective. This study aimed to analyse air ambulance operations due to cardiovascular disease (CVD) in the Arctic and employ the result as an instrument for future suggestions. Melting ice in the Arctic Sea opens new prospects for shipping, adventures, and oil/gas industry.

Material and methods. In February 2010 all air ambulance operations performed in the Arctic during the period 1999 to 2009 were analysed. The population of this study covered patients with CVD. The state of emergency, state of seriousness (the National Advisory Committee on Aeronautics (NACA) scale was used), flight time, destination, and flying time were the main outcome measures. A total of 45 patients (myocardial infarction 31, angina pectoris 11, and heart failure 4 patients) were identified. There were 39 Norwegians and 6 people of other nationalities. The mean age was 57 years (range 43–83 years)

Results. Thirteen cardiac incidents occurred in June and July. Most cases (26 patients) were considered urgent or emergent, and the mean NACA score was 4 (range 3–6). The adjusted female/male ratio was 0.222, and the median flying time (one way) was 3 h 25 min (range 1 h–6 h 40 min). Four flights were delayed, and one fifth of patients were transported during the night (midnight to 8.00 AM).

Conclusions. Air ambulance operations in the Arctic experience significant challenges. In the near future more shipping and polar adventure operations together with new oil and gas installations will increase the demand for health care support. Telemedical installations on-board vessels and rigs will be important for remote consultation and treatment.

Key words: Arctic, cardiovascular disease, air ambulance

INTRODUCTION

The worldwide climate changes are most easily observed in the Arctic. Here the ice is melting. Whereas the ice reflects the sun, open water absorbs the heat and speeds up the melting process. In the near future there

will be seasons with huge areas of open sea in the Arctic. Shipping may take advantage of new routes from the Atlantic Ocean through the Arctic Sea to the Pacific Ocean. Employing these routes, the distance by boat between Europe and the Pacific areas of America and Asia may be

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shortened by about one third and travelling expenses saved.

There are, however, several challenges. The Arctic experiences bright summers, but there are seasonable darkness and polar nights. For example, the citizens of Longyearbyen Svalbard have four months of seasonable darkness with no sun (7 October–8 March), two months (14 November–30 January) of complete darkness (“polar night”), and four months of midnight sun (20 April–23 August). Due to the significant seasonable variations, the Arctic Sea routes will (at least for the next few decades) be available only during summer and autumn. The rough weather conditions in the Arctic, often with strong winds, ice, and cold temperatures, may cause several obstacles for air ambulance operations. At Longyearbyen airport the highest and lowest temperature measured are +21.3°C and –46.3°C, respectively. The combination of strong wind and dry cold air causes significant risk of damage by frost. The strongest wind measured at Longyearbyen is 41.2 m/sec (wind gust) and generally half of the days in January have wind speed above 10 m/sec (www.met.no).

Today polar adventure operations in the Arctic have become steadily more popular, and during the summer time cruise liners access the coast of Greenland and north of Svalbard. In the near future, Svalbard may become even more important for air ambulance operations in the Arctic. Today, the Norwegian health care service in the region is based at the small hospital unit located at Longyearbyen, Svalbard. Due to limited staff, the hospital serves as a “preparedness hospital” taking care of primary health care and



Figure 1. The Arctic Sea (http://benmuse.typepad.com/ben_muse/arctic/). The white cover is the Arctic ice in September 2007

casualties, and offers emergency care and stabilisation of patients prior to transportation to the mainland. Long flights, risk of “white outs” (snow and ice coverage erasing the contours of the landscape), and almost no alternative for landing makes it necessary to be cautious regarding safety. In this setting, telemedical services may be beneficial. In order to get an idea of how to offer future health care to seamen, tourists, fishermen, and explorers in the Arctic, air ambulance operations due to cardiovascular disease (CVD) in the Norwegian Arctic were investigated.

Although the cold climate of the Norwegian Arctic introduces an increased risk of CVD, we have no statistics on CVD in the region. The number of CVD patients handled by the Norwegian air ambulance may, however, give an idea of the situation.

MATERIAL AND METHODS

The remotely located Arctic is shown in Figure 1. The great majority living in the Norwegian Arctic are situated on the Svalbard islands. According to data from Statistics Norway (www.ssb.no) as of January 2009, there were a total of 2,570 inhabitants (2,085 Norwegians, 470 Russians, and 10 Poles) on the islands. Males constituted 58% of the Svalbard population. The main airport is located at Longyearbyen, but there is also a smaller one at Svea. The industries on the islands include coal mining, tourism, satellite services, education, and research. There is a rich fishery in the Svalbard zone and fishermen from various nations such as Great Britain, Germany, Spain, Portugal, Russia, Iceland, the Faeroe Islands, and Norway work in the area. A few people also live on Bear Island, Hopen, and Jan Mayen.

The population on Svalbard is young. To gain permanent access to the islands, people have to be employed or either married to or a live-in companion of an employee. There is no social security system. Retired people thus have to return to the mainland. However, visitors and tourists do not have to deal with any age limit.

Despite its remote location, the population in the Arctic expect access to high quality specialist health care service. The hospital unit at Longyearbyen is run by the University Hospital of North Norway (UNN) trust and is staffed by three medical doctors (one surgeon and two general practitioners). There are 700 inhabitants per doctor. The distance to the main unit in Tromsø is 600 nautical miles.

Cold weather conditions increase the risk of cardiovascular disease (CVD). Exposure to cold air causes a rise in blood pressure and haemoconcentration which leads to increased tendency for vascular thromboses [1]. People diagnosed with a CVD in the Norwegian Arctic are in general transported to the mainland. They are transport-

Table 1. The National Advisory Committee on Aeronautics (NACA) scale

Score level	Patient status
NACA 0	No injury or illness
NACA 1	Not acute life-threatening disease or injury
NACA 2	Acute intervention not necessary, further diagnostic studies needed
NACA 3	Severe, but not life threatening disease or injury; acute intervention necessary
NACA 4	Development of vital (life threatening) danger possible
NACA 5	Acute vital (life threatening) danger
NACA 6	Acute cardiac or respiratory arrest
NACA 7	Death

ed by air ambulance. To administrate the air ambulance operations in Norway, the four Regional Health Authority (RHA) trusts have established a company named Luftambulansetjenesten ANS (www.luftambulanse.no). This company administrates tender for the supply of air ambulance operations. In northern Norway air ambulance operations are performed by the company Lufttransport AS (www.lufttransport.no). They employ Beechcraft King Air 2002/B200 aeroplanes in their Arctic operations. Air operations in the area are also run by the Norwegian coast guard (employing Lynx helicopters onboard their vessels) and the Governor of Svalbard (operating a Super Puma helicopter at Longyearbyen). These resources were not included in the survey. However, due to range limitations and the consequent logistic challenges, the Lynx and Super Puma helicopters generally transport patients to Longyearbyen for care and further transportation to the Norwegian mainland by aeroplane. These patients are thus indirectly included in this survey.

In February 2010 the LABAS database (www.luftambulanse.no) on activities in the Arctic performed by the Lufttransport air ambulance fleet was analysed focusing on the time period from 1 January 1999 until 31 December 2009. All operations involving patients diagnosed with CVD were selected. The following data recorded by the medical crew [specialised nurse (specialised in ana-

esthesiology or intensive care) or medical doctor] on a LABAS specific report sheet was registered (<http://www.luftambulanse.no/filarkiv/Div.%20dokumenter/Brukerveiledning%20fly.pdf>). The pilots did not have any medical qualifications.

Flight data: Date and time at start and end of flight, time spent, state of emergency (non-urgent, urgent, emergent) according to Norwegian Index for Medical Emergency Assistance [2], destination (hospital), and delay (> 15 minutes) were recorded.

Patient data: Sex, age, nationality, oxygen support, intubation, analgesics given, and state of seriousness (National Advisory Committee on Aeronautics, NACA) scale were registered. The scale is visualised in Table 1.

When CVD was suspected, ECGs were mailed or sent by fax to the University Hospital of North Norway in Tromsø for consideration by a cardiologist. This was performed when the medical doctor at Longyearbyen hospital requested remote advice. In recent years, ECG has been implemented as part of the hospital's electronic patient record (EPJ) system, named DIPS (www.dips.no). When ST-segment elevation myocardial infarction was diagnosed and no contraindications were revealed, patients were treated with thrombolytic therapy and transferred to UNN for mechanical reperfusion in terms of percutaneous cardiovascular intervention (PCI). In general, the

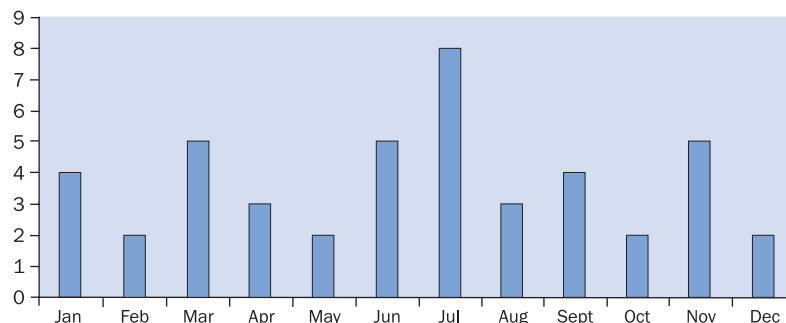
**Figure 2.** Number of CVD patients related to the months of the year

Table 2. Demographic, clinical, and treatment parameters of patients transported by air ambulance in the Norwegian Arctic during the period 1999–2009

Patient characteristics (n = 45)			
	Patients	(%)	Median age (range)
Age	45	(100)	57 yrs (43–83 yrs)
Sex			
Female	5	(11)	63 yrs (53–75 yrs)
Male	40	(89)	56 yrs (43–83 yrs)
Nationality			
Norwegian	39	(87)	
Not Norwegian	6	(13)	
Emergency status			
Non-urgent	9	(20)	
Urgent	16	(36)	
Emergent	20	(44)	
Treatment			
Intubation	0	(0)	
Oxygen	33	(73)	
Analgesics	24	(53)	
Vasopressors	26	(58)	
NACA* (0–7 scale)			
NACA 3	4		
NACA 4	36		
NACA 5	4		
NACA 6	1		

*— National Advisory Committee on Aeronautics (see Table 1)

effect of thrombolytic therapy on ST elevation predicts the state of emergency (urgent or emergent).

STATISTICAL ANALYSIS

Microsoft Office Excel 2007 (Microsoft Corporation, Redmond, Washington, USA) was employed for the calculations and database. Statistical Package for Social Science (SPSS) version 16.0 (SPSS Inc. Chicago, Illinois, USA) was employed for statistical analyses. Cases with an unknown value for a particular variable were excluded from analysis involving that variable. Statistical analyses were performed employing descriptive statistics. Due to the limited number of patients, no further statistical analyses were performed.

RESULTS

During the study period, a total of 345 patients were transported by the Lufttransport air ambulances in the Arctic. Among

these, there were 45 patients (13%) with cardiovascular disease. They suffered from acute myocardial infarction (31 patients), heart failure (4 patients), and angina pectoris (11 patients). Twenty-five patients experienced their first myocardial infarction. The patient characteristics are shown in Table 2. There was a male dominance with a female/male ratio of 0.125. Adjusting for the male dominance in the population and focusing on the 50–70-year-old age group (64% males, 36% females), the corrected figure was 0.222.

Most cases were observed in July (8 patients). Details are shown in Figure 2. During summer time many tourists visit Svalbard, and the cohort at risk is increased

All air ambulance flights were from Spitsbergen and Jan Mayen (2 patients) to the Norwegian mainland. Except for one case (to Sandefjord), they were all trans-

ported to the University Hospital of North Norway located in the city of Tromsø. Aircraft operations in the Arctic are associated with long distances and, consequently, significant flying time. The median time spent flying in this survey was 3 h 25 min one way (range 1 h–6 h 40 min). Nine patients were transported during the night (midnight–8.00 AM) and four of them during the time of seasonable darkness. In total, only 4 operations were delayed by more than 15 minutes.

None of the patients died during transport (NACA 7), but four patients were considered to be in acute vital life threatening danger (NACA 5) and one patient experienced acute cardiac or respiratory arrest (NACA 6). Details are shown in Table 2.

DISCUSSION

In this study, air ambulance operations in the Norwegian Arctic during which a CVD was disclosed were analysed. Despite a small sample size, this survey is (to the author's knowledge) the largest series of documented CVD patients from the Polar Regions (Antarctic and Arctic). Although all air ambulance operations were included according to the LABAS database, there were air operations performed by other resources. The Norwegian coast guard operated Lynx helicopters onboard several of their vessels [3], and the Governor of Svalbard employed a Super Puma helicopter at Longyearbyen for reconnoitring, search, and rescue operations. However, generally these helicopter resources brought the CVD patients to the hospital in Longyearbyen for further stabilisation and transport to the Norwegian mainland. The great majority of the CVD patients taken care of by the crew on the Lynx or Super Puma helicopters were thus included in this survey.

CVD patients constituted only 13% of the total air ambulance operations, and the median age in this subgroup was 57 years. The low share is probably due to the fact that there is a young population living on the Svalbard islands. Retired people do not obtain permanent access to the islands and have to return to the mainland. Cruise liners operating in the area frequently have medical staff onboard. This may have influenced the result (13% CVD patients) as CVD patients may have been treated onboard the vessels whereas trauma patients were evacuated.

The 50–70-year-old age group generally have a higher risk of CVD. In this cohort there was a significant dominance of males (64% males). This explained the low number of females with CVD (5 patients). The higher average age among female patients was probably by chance.

Air ambulance services are an important part of specialised health care. In remote areas such as the Arctic,

rough and extremely cold weather conditions, seasonable darkness, and almost no alternative for landing may cause significant challenges. However, despite single episodes of engine problems, the two engine Beechcraft King Air 2002/B200 airplanes have proven to be safe. No airplane or crew were lost in the Arctic during the study period. This may be due to the constant focus on safety by the company Lufttransport.

As illustrated by the median one-way flying time (3 h 25 m), there are significant distances in the Arctic. Such a time span has also been shown when employing heavy search and rescue helicopters in the Barents Sea [4]. The median time spent from the alarm to first patient contact was 3.3 hours, and the median duration of the mission was 7.3 hours. The complexity of running operations in remote and cold areas has also been illustrated in Antarctica [5]. In this report a ski-equipped airplane was employed and a critically ill patient was transported 9 hours north to New Zealand. In such a setting, it is of utmost importance that people beside the patient know what to do or can achieve remote guidance while the air ambulance is on its way.

CVD is, together with trauma, the most common cause of air ambulance operations in Norway. In the study by Zakariassen et al., cardiovascular disease was the most frequent cause of emergency contact outside hospital [6]. This was confirmed in another Norwegian survey reporting cardiovascular disease accounting for 35% of all patients [7].

As the ice in the Arctic is melting due to worldwide climate changes, shipping may take advantage of new Arctic routes between Europe, Northern Russia, Asia, and North America. Furthermore, polar adventure operations and activities related to the oil and gas resources in the Arctic Sea will increase in the near future. This will call for the presence of specialised health care and a day and night telemedical service. In such a setting, Svalbard may become even more important as a base for air ambulance services in the Arctic. Besides a minor hospital and an airport, Longyearbyen is also a base for an important satellite business. Here data from satellites in polar orbits are received and communicated worldwide through a fibre-optic cable to the Norwegian mainland or to geostationary satellites. Such an infrastructure is not available this close to the North Pole anywhere else in the world. Svalbard is thus a natural base for health care services in the Arctic.

In the Arctic Sea, satellite communication has to rely on satellites in polar orbits as the geostationary ones (above Equator) are usually not accessible this far north. In the future, it should be mandatory that ships crossing the Arctic

Sea have communication systems accessing satellites in polar orbits. This would make it possible to install portable ECGs onboard the vessels and the officers could send an ECG to a cardiologist for remote diagnosis and guidance concerning therapy. When acute myocardial infarction is diagnosed, thrombolytic therapy could be initiated according to specific guidelines and evacuation of the patient planned and organised based on location, patient condition, and effect (changes in ST elevation) of therapy.

Due to the significant challenges caused by distances, weather conditions, lack of infrastructure, etc., the establishment of an Arctic medical service centre offering remote telemedical advice should be considered. Active collaboration across countries in this setting is of the utmost importance. Evacuation (at least) in the Norwegian Arctic should be performed in cooperation with the Joint Rescue Coordination Centre North Norway (<http://www.hovedredningssentralen.no/english/index.asp>). High quality decision criteria of aero-medical evacuation are important for safe operation [8–10]. Duchateau et al. [8] concluded that patient age, availability of local resources, and location are the main criteria associated with the need for immediate aero-medical evacuation. This has also been summarised by Isakov with the words “right patient, place, and time” [9]. Air ambulance service is costly and, especially in the Arctic Sea, limited in terms of resources.

Whereas air ambulance operations have been documented as cost-effective in small countries such as the Netherlands [11], the cost and risk factors are different in remote Arctic areas. Nevertheless, it is still important to achieve maximum value (health gain) for money. In such a setting an excellent fleet coordination system is mandatory. Knowing the discussions concerning further development (shipping, fishery, oil/gas industry) of the Arctic Sea, the cost effectiveness of the health care infrastructure (including air ambulance services) should be further investigated.

Despite remote telemedical services and well-organised evacuation systems, it should be kept in mind that seafarers are generally exposed to several cardiac risk factors aboard (i.e. lack of exercise at sea, high stress levels, and often high-fat diet). In the Arctic this risk is increased due to low temperatures increasing blood pressure. The cold Arctic is definitively not the right place for patients suffering from significant coronary heart disease. It should therefore be discussed whether passengers participating in polar adventure operations should have a declaration from their personal physician that they are really fit for the journey. Polar adventure operations are very different from “tropical” cruise lines [12].

CONCLUSION

Air ambulance operations in the Arctic experience significant challenges due to long distances, rough weather conditions, and almost no alternative for landing. In the near future more shipping and polar adventure operations together with new oil and gas installations will increase the demand for health care support. Telemedical installations onboard vessels and rigs will be important for remote consultation and treatment.

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