BMJ Open

A prospective observational study of why people are medically evacuated from offshore installations in the North Sea

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To cite: Waje-Andreassen A, Østerås Ø, Brattebø G. A prospective observational study of why people are medically evacuated from offshore installations in the North Sea. *BMJ Open* 2020;**10**:e037558. doi:10.1136/bmjopen-2020-037558

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-037558).

Received 06 February 2020
Revised 11 May 2020
Accepted 01 June 2020

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ABSTRACT

Objectives Few studies have described evacuations due to medical emergencies from the offshore installations in the North Sea, though efficient medical service is essential for the industrial activities in this area. The major oil- and gas-producing companies' search and rescue (SAR) service is responsible for medical evacuations. Using a prospective approach, we describe the characteristics of patients evacuated by SAR.

Design and setting A prospective observational study of the offshore primary care provided by SAR in the North Sea.

Methods Patients were identified by linking flight information from air transport services in 2015/2016 and the company's medical record system. Standardised forms filled out by SAR nurses during the evacuation were also analysed. In-hospital information was obtained retrospectively from Haukeland University Hospital's information system.

Results A total of 381 persons (88% men) were evacuated during the study period. Twenty-seven per cent of missions were due to chest pain and 18% due to trauma. The mean age was 46.0 years. Severity scores were higher for cases due to medical conditions compared with trauma, but the scores were relatively low compared with onshore emergency missions. The busiest months were May, July and December. Weekends were the busiest days.

Conclusion Three times as many evacuations from offshore installations are performed due to acute illness than trauma, and cardiac problems are the most common. Although most patients are not severely physiologically deranged, the study documents a need for competent SAR services 24 hours a day year-round. Training and certification should be tailored for the SAR service, as the offshore health service structure and geography differs from the structure onshore.

Strengths and limitations of this study

- ► We expect this study to be accurate and to reflect the real situation of the search and rescue (SAR) service, as the study has very few excluded patients and missing data.
- ► Standardised patient record forms were filled out by SAR nurses during the evacuation, but in some cases the information was recorded afterwards, which could lead to recall bias.
- ► Small changes were made to the standardised forms after March 2015.
- ► Because the changes were minimal, we included data from this period in the analysis.

INTRODUCTION

Oil and gas is a substantial industry in Norway. Equinor (formerly Statoil) is the largest oil- and gas-producing entity in the North Sea. This company established their helicopter-based search and rescue (SAR) service in 1981 and has since developed and improved this service to be the most important factor in the chain of offshore medical evacuations (medevacs). According to legislation, the offshore operators are responsible for the acute medical emergency preparedness, making an effective emergency medical service with highly skilled personnel essential. However, the demanding and potentially dangerous industrial environment of oil and gas production, combined with rough climatic conditions, makes this challenging.

Trauma is a risk in the offshore environment due to falling objects, lifting of heavy equipment using cranes, and the operation of other heavy or rotating tools.[1] In addition, oil and gas extraction obviously involves a risk of explosions or blowouts.[2] Shift work is also used in the offshore industry and, even though they are not conclusive, studies indicate that shift work in general, and night work in particular, is associated with gastric problems and increases the risk of injuries.[3 4]

Few reports have described Equinor's SAR service. Previously, medevacs were most commonly due to trauma, but as health and safety measures have improved, evacuations due to medical illness have increased. Some studies of medevacs from offshore industry have indicated a reduction in the proportion

of trauma compared with illness.[5–7] A retrospective pilot study of Equinor's SAR patient population in 2006 demonstrated similar findings.[8]

Thus, the aim of this study was to assess the patients evacuated from offshore installations and describe their age, diagnoses and severity, temporal distribution and urgency of evacuation. In addition, we wanted to assess the outcome after hospital admittance, describe mortality and the length of hospital stay and compare our findings with the onshore ambulance services (HEMS).

METHODS

This prospective observational study is based on the air ambulance missions from oil and gas installations registered by Equinor's SAR service from 1 January 2015 to 31 December 2016. The service may also occasionally be used for medevacs from fishing boats and other commercial vessels (3%) in the North Sea. To cover the area within certain time limits, Equinor's SAR helicopters are located at three offshore platforms: Statfjord B, Oseberg and Heidrun. In addition, two helicopters are based onshore at Sola and Hammerfest. Medevacs from the SAR bases at Statfjord B, Oseberg, Heidrun and Sola were included. Hammerfest in northern Norway was excluded from the study because this location did not have access to the electronic record system during this period. Estimates suggest that there were about 7000 personnel working in the study area at any given time. (Personal communication RJ Grindheim, Equinor leader of Logistics Offshore Air, 2020.)

On board each SAR helicopter is a specially trained nurse anaesthetist, a rescue specialist, an hoist operator and two pilots.[5] The SAR nurses are certified yearly through comprehensive theoretical and practical qualification, and capability tests on advanced life support level. All medical protocols are created in cooperation with the specialist departments at Haukeland University Hospital. An onshore physician is always available for consultation and can be reached through both phone and video communication. The latter has been useful if the decision to activate a medevac operation is difficult and allows earlier appropriate treatment (eg, thrombolysis in acute myocardial infarction).[9]

Standardised forms are filled out by SAR nurses during every medevac and entered into Equinor's electronic patient record system ('Pride Journal') after each mission ends. All SAR helicopter flights are registered by air transport services ('TransAir'), and all medevacs are registered by a SAR nurse in the 'Pride Journal'. Out of the registered medevacs in the 'Pride Journal', some were excluded due to family causes onshore, double registration, the patient being deceased before SAR arrival offshore or multiple patients on the same flight. In cases with more than one patient evacuated at the same time, the patient with less severe medical issues was excluded due to the impact on our analyses, which could be a cause of bias (figure 1). Two missions were registered as ambulance mission by TransAir, but lacked patient information registered in Pride Journal. These two missions were therefore excluded from the study. Additional information on patients admitted to Haukeland University Hospital was obtained from the hospital records.

The diagnosis categories used in the standardised forms were similar to the standardised data set for documentation of prehospital services suggested by Krüger *et al*.[10] The 10 main diagnostic categories were: cardiac arrest, trauma, breathing difficulties, chest pain, stroke, acute neurology excluding stroke, psychiatry including intoxication, obstetrics and childbirth, infection and other non-specified diagnoses. In addition to the 10 diagnostic categories already included in the patient records, two more were added, 'Abdominal pain' and 'Arrhythmia', to give a more accurate description of 'Other' for non-specified diagnoses. In the mission records categorised as 'Other' based on the written information specifying the assumed diagnosis, those mentioning abdominal pain or arrhythmia were re-classified.

To prioritise the missions, all medical emergency calls in Norway are categorised into three groups (red, yellow and green) according to the Norwegian Index of Emergency Medical Assistance.[11] A red response is a patient presenting with a potentially life-threatening condition. A yellow response is urgent, but not considered as life-threatening at the moment, whereas a green response is a patient in stable condition that is not expected to get worse. The priority was set by the nurse on duty at the offshore installation based on the initial available information on the mission.

The mission severity was based on the National Advisory Committee on Aeronautics (NACA) scale to estimate prehospital severity.[12] It is an ordinal 8-point scale, and the patient is scored based on their most severe condition during the observation period. Studies have shown good correlation between NACA score and patient morbidity and mortality.[13 14]

Data from 'TransAir' was registered using Greenwich Mean Time (GMT), which is used as a standard in aviation, whereas the SAR nurses mainly registered their missions using Norwegian time (GMT+1 during winter and GMT+2 during summer). In some cases, time was registered in GMT by the SAR nurses. All time values were adjusted to the same time zone.

The Worthing Physiological Scoring System (PSS) was used to calculate the degree of physiological derangement at the time the patients were admitted to the emergency department (table 1).[15] Studies have shown that Worthing PSS has good prognostic value to predict the probability of mortality and can be used as an early warning score.[15 16] It was also chosen to enable us to compare scores for our patient group to similar groups onshore in Western Norway.[17] The PSS score was calculated based on the patient's physiological status when arriving at the emergency department. To further assess in-hospital outcome, we collected data on length of hospital stay, number of patients who needed emergency intervention and to

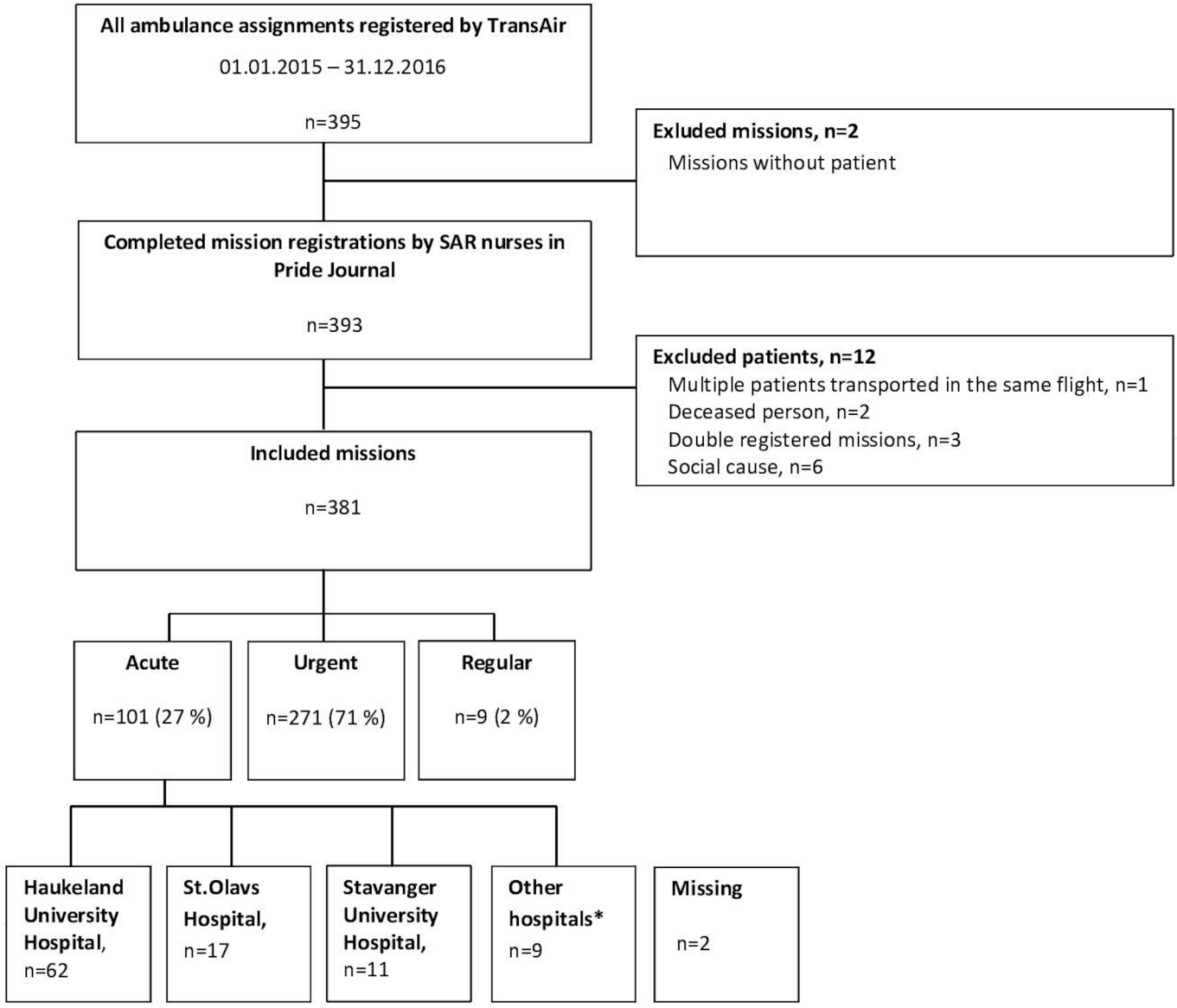

Figure 1 Included patients. SAR, search and rescue.*Including Kristiansund Hospital, Bodø Hospital, Sandnessjøen Hospital and Molde Hospital.

which hospital unit the patients were admitted. Emergency interventions were defined as potentially life-saving emergency procedures within the first 24 hours after hospital admittance, including emergency surgery, angiography/percutaneous coronary intervention, thrombolysis or endotracheal intubation.

Statistical methods

We used descriptive methods to characterise the sample. Normally distributed data are reported as the mean and SD, other data as median and IQR.

Data were analysed using IBM SPSS Statistics for Windows V.24 (IBM Corp, Armonk, New York, USA).

Patient and public involvement in research

Patients and public were not involved in the design or planning of the study.

RESULTS

During the 2-year study period, a total of 395 medevacs were registered, 381 of which were included in the analysis (figure 1).

Diagnosis distribution

As shown in figure 2, 'Chest pain' represented the largest patient group (27%), followed by 'Abdominal pain' and 'Trauma', representing 20% and 18% of evacuations, respectively. The mean age of evacuated patients was 46.0 years, and 88% of evacuees were men. Out of the 381 SAR missions, 27% (n=101) were prioritised as acute, 71% (n=271) as urgent and 2% (n=9) as regular missions. Stroke, chest pain, and other cardiac-related conditions represented the majority of acute missions. We also found that 18% of the medevacs were due to trauma, not medical illness.

Table 1 The Worthing Physiological Scoring System (HEMS)

	Score			
	0	1	2	3
Breathing				
Respiratory rate (per min)	≤19	20 to 21	≥22	
Oxygen saturation in air (%)	96 to 100	94 or 95	92 or 93	≤91
Circulation				
Pulse rate (per min)	≤101	≥102		
Systolic blood pressure (mm Hg)	≥100		≤99	
Temperature (°C)	≥35.3			≤35.2
Disability				
AVPU*	Alert			Other

*AVPU, Alert, responsive to Verbal stimuli, response to Pain, or Unresponsive; table is modified from Duckitt *et al*[15]

The registration of mechanism of injury in the evacuated trauma patients was incomplete. However, of the 20 patients registered with mechanism of injury, 40% were due to fall, 25% due to crush injury, 10% due to each of the categories cuts and electricity, and 5% to each of the categories burn, chemicals and foreign bodies in the eye. Out of the 47 patients registered with localisation of injury, 45% were the upper limb, 34% the lower limb, 11% head injury and 6% eye injury.

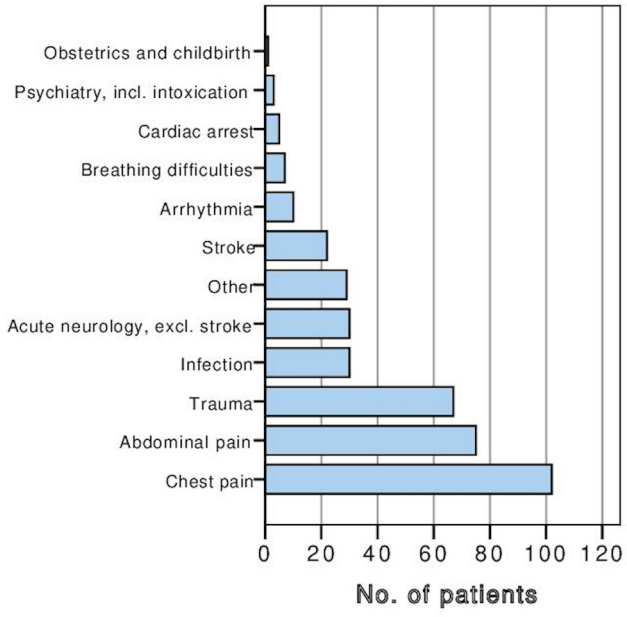

Figure 2 Diagnosis distribution by number of patients.

Table 2 Comparison of patients evacuated by SAR and onshore air ambulance services (HEMS)

	SAR patients (n=187	HEMS (n=250)*
Discharged from hospital alive, n (%)	186 (99.5)	220 (88.0)
Physiology in ED		
Proportion of patients with Worthing PSS >1 at arrival in ED, n (%)	34 (18.5)	96 (46.6)
Median Worthing PSS, median (25th to 75th percentile)	0	1 (0 to 3)
Emergency interventions within 24 hours of admittance to hospital, n (%)	27 (14.4)	64 (26.1)
Admitted to ICU or HDU, n (%)	9 (4.8)	109 (44.5)
Median length of hospital stay, days (25th to 75th percentile)	1 (0 to 2)	3 (1 to 8)
Length of hospital stay >10 days, n (%)	7 (3.7)	45 (20.5)

*Results from Østerås *et al*[17]
ED, emergency department; HDU, high dependency unit; ICU, intensive care unit; PSS, Physiological Scoring System; SAR, search and rescue.

Severity of conditions

The mean NACA severity score for patients with an illness was 3.1 and for trauma patients 2.6. The median NACA score was 3.0 for both categories.

Table 2 shows our findings compared with a study of a Norwegian emergency patients evacuated by HEMS.[17] Our study shows that nearly all our patients were discharged alive. Physiological scoring in the ED showed that fewer patients had a Worthing PSS score ≥1 in our study compared with the HEMS patients, among which almost 1/2 had a PSS score of at least 1. Of the offshore patient population, 1/7 had an emergency intervention performed in hospital within the first 24 hours, and 1/20 were admitted to the intensive care unit (ICU) or high dependency unit (HDU). The median length of hospital stay was 1 day, and 1/25 patients admitted to Haukeland University Hospital stayed at the hospital for more than 10 days.

Variation during the year, week and day

We found little difference in the frequency of medevacs during the first days of the week, but the numbers increased towards the weekends, with Friday and Saturday as the busiest time of the week (figure 3A). Our study found a small variation in the number of medevacs during the year, with an increase during May, July and December (figure 3B).

The distribution of mean PSS score during the week varied from 0.42 (Wednesday) to 0.93 (Tuesday). The busiest day of the week, Saturday, had a mean PSS score of

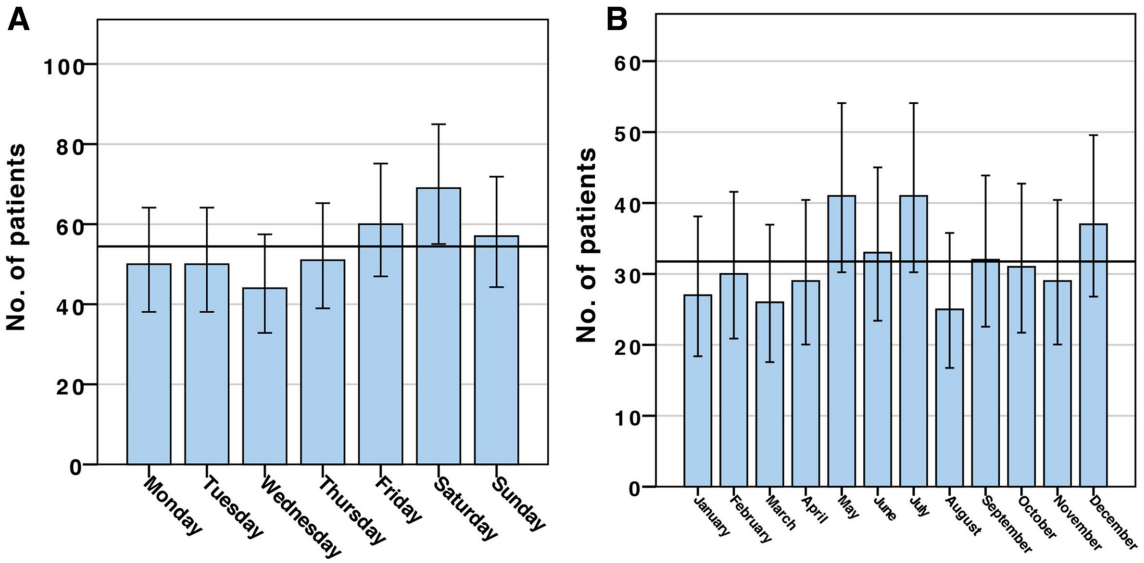

Figure 3 Variation throughout the week (A) and year (B).

0.69. The mean NACA score varied from 3.06 (Monday) to 3.33 (Friday).

The SAR service was most frequently scrambled during the day and evening (06:00 to 00:00), and only acute or urgent patients were evacuated during the night (00:00 to 06:00). The acute missions were more uniformly distributed over the day and night compared with urgent and regular missions.

Length of hospital stay and outcome

Out of the 101 missions registered as acute, 62 were admitted to Haukeland University Hospital. Of these, one died in-hospital from a heart attack 10 days after hospitalisation. Within the first 2 days, 44% of the patients admitted to the hospital were discharged.

DISCUSSION

Our study shows that the three main causes of medevac by SAR were due to chest pain, abdominal pain and trauma. This is in accordance with other studies and reports.[5 7 8] Other studies have used other classifications, such as 'musculo-skeletal', 'trauma', and 'digestive', but these terms somewhat overlap one another.[6 18]

We found that nearly one-fourth of medevacs was registered as acute, but most were registered as urgent and only a few as regular. This differs from the urgency distribution for the onshore Norwegian Air Ambulance, as almost four out of five patients are evacuated due to acute conditions.[19] These differences are expected because acute and urgent missions need to be evacuated by the SAR service immediately, whereas regular patients can be transported onshore with scheduled transport helicopters. Onshore, the urgent patients can be transported by ground ambulance.

The mean age of patients evacuated from offshore installations was 46.0 years. The average age of Equinor's employees in 2015 was 47.3 years. It may seem confusing that the mean age of evacuated patients was slightly less than the average age of the working population offshore, but many of the personnel working offshore are employees of subcontractors. They tend to be younger than those employed by Equinor. Most of the evacuated patients (88%) were men, which is explained by the fact that most offshore employees are males. (Personal communication, AH Ringheim, Equinor, 2017.)

Our study found that trauma only represented 18% of medevacs during the study period. A UK study of offshore medevacs found that 75% of the missions in 1980 were due to trauma. This proportion was reduced to 50% in 1984.[6] Furthermore, a 2006 Norwegian study of Equinor's SAR service in the Tampen area found that trauma represented 30% of the evacuations in the period between 1996 and 2005.[5] Our findings indicate that the proportion of trauma evacuations from offshore installations has been reduced substantially. This reduction may be a result of stricter standard operative procedures and better education and training of the employees. It could also be a result of the 'offshore population' getting older and being more likely to be affected by regular acute medical diseases that cannot be ruled out by the required health certificate for offshore personnel.[20] The true explanation is most likely a combination of both.

Most of the trauma injuries were caused by falls, and almost half of the injuries were located in the upper limb. However, the registration was incomplete, so further studies are needed to make any conclusions.

The NACA scores indicated that the condition of evacuated patients due to illness was more severe than the condition of medevacs due to trauma. However, most of the traumas were not life-threatening. Among the patients evacuated due to illness, one died. Two of the patients were registered with NACA 1, which according to the NACA scale does not need any medical supervision or treatment and could, in retrospect, have been avoided.[12]

The patients in our study tended to score lower on the Worthing PSS, had less need for early emergency interventions, were less often admitted to ICU or HDU, and had a shorter stay in the hospital compared with the patients transported by the onshore ground and helicopter ambulance service in the western region of Norway.[17] This may indicate that the offshore patient group represents a healthier patient group than the population onshore. In addition, a valid health certificate is needed to work offshore, which means that the population offshore should be healthy. Elderly persons with chronic diseases are not found offshore. It is also important to keep in mind that the transport times from offshore installations are often longer than for most ground and helicopter ambulances onshore. The treatment provided by SAR nurses during the long flight could have an impact and improve the physiological status of the patients when later measured in the emergency department. A number of patients are also transported onshore for more extensive medical diagnostic workups.

We found an increase in medevacs during May and July. This increase could be explained by an increase in the number of employees offshore due to maintenance work during the summer. The exact number of persons who are offshore at a given time has been impossible to estimate with certainty. Thus, we were unable to calculate incidence rates. Similar findings were described in a study on medevacs from German offshore wind farms, where summer is the busiest time of year and Sundays the busiest day of the week.[21] Our study also showed an increase in medevacs during December. This is surprising as there is little or no maintenance work during this time of year. It would be interesting to study this over several years to determine whether this is a random finding, in addition to exploring the underlying causes.

The weekends, especially Friday and Saturday, were the busiest days during the week. This is similar to a report on Statoil's (which became Equinor) SAR service from 2013/2014, as it found that Fridays and Sundays were the busiest time of the week.[8] The slight difference in which day during the weekend is busiest may be due to random distribution, as the number of regularly scheduled helicopter flights is low during the weekend. If illness or trauma occurs on a Friday or Saturday, SAR medevac may be needed more often because it is a long time until the next scheduled flight on Monday.

Our study showed that the mean Worthing PSS score was lowest on Wednesdays and highest on Tuesdays. Saturdays had a mean Worthing PSS score of 0.69. It would be more intuitive that the PSS and NACA scores should have been lowest on Saturdays due to the longer wait for the scheduled helicopter on Monday for the patients registered as 'regular'. The non-consistency can be a random finding and may be due to the patient population being a relatively healthy population.

The medevacs were most often performed during daytime. The distribution of acute medevacs did not vary through the day, as expected, as any patient with an acute condition needs to be evacuated as soon as possible.

Out of the 101 medevacs registered as acute, 61% were admitted to Haukeland University Hospital. A total of 89% of acute medevacs were admitted to University Hospitals (Haukeland, St Olavs and Stavanger). These hospitals are all public hospitals following the same guidelines, and it is assumed that an illness or trauma would get the same treatment, independent of which hospital the patient is delivered to. Therefore, we can assume that data from this hospital reflects the situation for the major acute patient population. Only one out of the 62 patients delivered to Haukeland University Hospital died in hospital. This patient was hospitalised due to circulatory arrest, which was successfully defibrillated before admission to the hospital, but he died in the hospital after 10 days.

Further studies should focus on patient outcomes after hospitalisation, time on sick leave before returning to work and level of disability. Studies should also observe what kind of treatment is provided before admittance to the hospital and the type of diagnostic equipment. One promising new tool is the microsound-based head scanner Strokefinder, which could be helpful in patients with symptoms of stroke.[22] The possibility of real-time video consulting during helicopter flights is also interesting.

Strengths and limitations of this study

Most standardised patient record forms were filled out by SAR nurses during the evacuation, but in some cases the information was recorded afterwards, which could lead to recall bias. This study was not originally designed for evaluating patient in-hospital outcomes.

Small changes were made to the standardised forms after March 2015, and the medevacs from 1 January 2015 to 1 March 2015 (n=35) lacked NACA scoring. We decided these NACA scores based on information and vital parameters from the patients' medevac records. Because the changes were minimal, we included data from this period in the analysis.

We expect this study to be accurate and to reflect the actual situation of the SAR service, as the study has very few excluded patients and missing data. As stated earlier, the operators are responsible for the medical service offshore. Still, in special situations, 'The Joint Rescue Coordination Centres' (HRS) may assist evacuations where the SAR service is not fully capable of performing the evacuation themselves.[23] It is reasonable to assume that possible missing data due to this would not have any significant impact on our results.

The results of this study may be useful for comparing the SAR service in this area to other medical services in similar locations. However, generalisation of our data should be done with care, as this study describes a special

rescue service on the Norwegian continental shelf and other rescue services may be organised differently.

CONCLUSION

There are three times as many evacuations due to illness than trauma for offshore installations. Cardiac problems are most common. This study describes patient evacuations from the North Sea and indicates that the patient characteristics differ from the onshore ambulance patient population due to both the structure of the health services and geographical differences. Therefore, the results indicate that a specialised and well-trained SAR service is necessary 24 hours a day year-round.

Acknowledgements The authors thank the Equinor representatives Arne MC Evensen, Atle H Ringheim, Solveig Engen, Fredrik Jervell and Rolf J Grindheim for providing information and support to accomplish this study. We also want to thank Jacek S Borg for his technical support, which made it possible for the authors to access all information about medevacs and flights during the study period.

Contributors The study was conceived by ØØ and designed by GB, ØØ and AW-A. ØØ and AW-A conducted the statistical analysis of the data. The initial draft of the paper was written by AW-A and GB. All authors were involved with revising the work and all authors approved the final submission.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval Data collection and analysis was approved by the management, the Union Representative and coordinating Safety Delegate of Equinor. The study protocol has been considered by the Regional Committee for Medical and Health Research Ethic of our region (REK) with no objection to the study or publication (2011/01287). The Ministry of Health and Care Services has accepted the protocol and made an exception from confidentiality, and The Norwegian Data Protection Authority approved the data collection and processing. The local Data Protection Official for Research also approved the collection, analysis and presentation of data.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. The data contained within this study can be obtained by writing to the corresponding author at email: annwaj@gmail.com.

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