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Original Research

Testing Quality Indicators for Physician-Staffed Fixed-Wing Air Medical Services in Iceland

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A B S T R A C T

Objective: Medical evacuation with fixed-wing air ambulances and rescue helicopters plays an important role in Iceland's emergency medical services. The objective of this study was to measure the quality of physician-staffed fixed-wing air ambulance services in Iceland using the 15 response-specific quality indicators (QIs) developed by the EQUIPE consensus group in Scandinavia.

Methods: Physicians working in the Icelandic fixed-wing air ambulance service were asked to register response-specific QIs in an online questionnaire after every physician-staffed patient transport undertaken by the service from March 1 to December 31, 2023.

Results: The fixed-wing air ambulance service in Iceland did not reach the benchmarks proposed by EQUIPE in 11 of 15 QIs tested. Furthermore, 7 QIs fell in the low performance zone and 4 in the average performance zone.

Conclusion: Sparse population density, long transports, and the lack of a single prehospital organizational structure are challenging for Icelandic physician-staffed emergency medical services. This is, to our knowledge, the first time that the quality of the service has been assessed from other perspectives than time and mortality alone. As a result, several areas in need of improvement have been identified in our study.

Iceland, a Nordic island country located in the North Atlantic Ocean, has a relatively small population compared with its landmass. With approximately 383,726 residents dispersed in the area of 103,000 km^2, the population density is only 3.76/km^2. Most inhabitants are concentrated in Reykjavík and its metropolitan area. Despite this urban concentration, Iceland preserves a significant number of rural settlements, and small towns and villages are scattered along its 6,000-km coastline.[1,2]

Despite its relatively small population and remote location, Iceland boasts a well-developed health care system. However, the only hospitals capable of providing advanced emergency care are in the capital city of Reykjavík and the town of Akureyri in northern Iceland. Medical evacuation using fixed-wing air ambulances and rescue helicopters plays a crucial role in Iceland's emergency medical services (EMS), as distances from incident sites to these hospitals can be long. The fixed-wing air ambulance service is based in Akureyri, whereas the National Coast Guard search and rescue helicopter service is located in Reykjavík. Both services are staffed with physicians. In Iceland, there is no single organization governing the prehospital response. Rescue helicopters are operated by the Icelandic Coast Guard, which is governed by the Ministry of Justice, whereas the fixed-wing air ambulance is operated by a private air service provider contracted by the Icelandic Health Insurance and governed by the Ministry of Health.[3,4] The government also contracts the services of emergency medical technicians and paramedics from regional fire departments or health care facilities, whereas ground ambulances are provided by the Icelandic Red Cross. This organization

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complicates the integration of prehospital services and may prohibit effective governance.[5] A task force from the Ministry of Health recommended creating a central, national EMS agency by 2025.[6] However, this plan has been postponed.

Previous research has raised concerns about the quality and timeliness of air ambulance service in Iceland.[7-9] Haugland et al[10] and the EQUIPE consensus group developed quality indicators (QIs) for physician-staffed EMS (P-EMS), both response specific and system specific. These QIs were tested at 16 bases across Scandinavia, and the pooled results were used to propose benchmarks for comparable P-EMS.[11] Each QI was categorized into 3 performance zones based on the dispersion of the results: the green zone indicates high performance (upper quartile), the yellow zone indicates average performance (interquartile range [IQR]), and the red zone indicates low performance (lower quartile). The benchmark was established at the transition between the green and yellow zones, indicating that performance at or above the 75th percentile in the reference data is considered high. This work has created opportunities for further research and improvement in the quality and organization of prehospital emergency services.

The objective of this study was to investigate the physician-staffed fixed-wing air ambulance service in Iceland using the 15 response-specific QIs developed by the EQUIPE group.[11]

Methods

Design and Settings

We conducted a prospective collection of data for physician-staffed fixed-wing air ambulance transports undertaken by the service based in Akureyri. In February 2023, all physicians working in the service received a written request to participate, and an online questionnaire was created on Formsite, where the response-specific QIs could be registered after each transport.[12] The 15 questions were a mixture of multiple choice (nominal variables) and restricted choice (time variables), definitions for the QIs can be found in the Appendix. Data were gathered from March 1, 2023, to December 31, 2023. Requests canceled due to poor weather conditions were not registered, and neither were missions for which a physician was not specifically requested but one was present on the airplane due to logistical reasons. This included situations such as return flights with patients onboard who were being transported to a lower level of care.

Statistical Methods

Data were prepared in Microsoft Excel[13] and analyzed using R version 4.3.[14] Descriptive statistics are reported. Outliers were not removed. Categorical QIs are revealed as proportions. The central tendency of continuous QIs is described with the median and corresponding IQR.

Research Approval

An application was sent to the National Bioethics Committee in Iceland (23-021), as data were collected without obtaining informed consent from the patients or next of kin. No patient-identifying information was collected, and regular clinical practice was adhered to. The committee concluded that permission was not necessary.

Results

During the data collection period, the service conducted 764 missions, transporting a total of 819 patients. On 309 of these flights, a physician was recorded as being on board the plane, although it was not specified whether their presence was by request or for logistical reasons. A total of 180 registration forms were obtained.

The fixed-wing air ambulance service in Iceland did not reach the EQUIPE group's proposed benchmarks for 11 of 15 QIs tested (Table 1). Of these 11 QIs, 7 fell into the low performance zone and 4 fell into the average performance zone.

The P-EMS was unable to respond immediately to 28% of the dispatches. The online questionnaire provided an option to indicate a brief explanation for delays. The primary reason, accounting for 64.4% of delayed responses, was that the primary P-EMS unit was engaged in another mission and the secondary unit either had a longer response time or was unavailable.

The median time from the Emergency Medical Communication Center receiving the alarm to P-EMS arrival at the patient's location was 70 (IQR 46-90) minutes, and the median time from dispatching P-EMS to the patient's arrival at the preferred destination was 140 (IQR 115-170) minutes. Median time spent on the scene was 23 (IQR 13-55) minutes. Only 1 patient died during transport, accounting for 1 of the 13 adverse events registered across 180 flights (7.2%). At the time of data collection, no other research projects were being conducted in the prehospital field, and access to clinical guidelines for the air ambulance was limited.

Advanced medical treatment was provided in less than 50% of dispatches. The service was considered a significant logistical contribution in 86% of the cases, and documentation was complete in 82% of the cases. The needs of relatives were addressed whenever

Table 1
QIs and Results Categorized in High, Average, or Low Performance Zones[11]

QI	Type of QI	Result	Unit of QI	Performance Zone
Able to respond immediately	Structure	72	%	Low
Time to arrival of P-EMS (median)	Structure	70	Minutes	Low
On-scene time (median)	Process	23	Minutes	Low
Time to preferred destination (median)	Process	140	Minutes	Low
Patient arriving to hospital alive	Outcome	99.4	%	High
Debriefed response	Process	67	%	Average
Adverse events	Process	7.2	%	Low
Complete documentation	Process	82	%	High
Guidelines for actual medical problem	Structure	17	%	Low
P-EMS involvement in dispatch	Process	51	%	Average
P-EMS necessary to provide appropriate care	Process	43	%	Average
Provision of advanced medical care	Process	48	%	Average
Significant logistical contribution	Process	86	%	High
Patients enrolled in research projects	Structure	0	%	Low
Care for relatives	Process	100	%	High

P-EMS = physician-staffed emergency medical service; QI = quality indicator.

they were present, though in 51.7% of the cases, no relatives were on the scene.

Discussion

The service met the set benchmarks in only 4 of 15 QIs, falling into the low performance zone for all structural QIs and the 2 time-variable QIs.

To our knowledge, this is the first prospective observational study of the Icelandic fixed-wing service's quality using the EQUIPE QIs. Sparse population density and long transport times to advanced medical care pose significant challenges for the Icelandic P-EMS. Harsh weather conditions and inadequate infrastructure at smaller airfields, resulting from reduced ground services and a decline in domestic passenger flights in recent years, can lead to significant delays.

Furthermore, existing contracts between aircraft carriers and the government present constraints. These contracts require a primary aircraft capable of carrying 2 patients on stretchers and a backup plane. However, the backup plane is not required to be identically equipped as the primary aircraft and can have a response time of up to 105 minutes. As mentioned previously, the availability of the 2 planes significantly affects the service's ability to respond immediately to dispatches.

Despite these challenges, the fixed-wing service makes a substantial logistical contribution to prehospital care and interhospital transports. It significantly shortens transport times compared with ground transport, and rural areas benefit from not having to deploy ambulances and specialized personnel for extended periods.

The EQUIPE QIs were previously tested in bases for helicopter and ground transport in Scandinavia, but it was only tested in a fixed-wing service in Iceland.[11] A comparison of fixed-wing EMS to helicopter EMS (HEMS) is unusual; however, the EQUIPE group's QIs were chosen for this investigation of the Icelandic fixed-wing air ambulance service, as they were comprehensive, previously tested in the field, and easy to register. We were unable to find comparable response-specific QIs specifically designed for fixed-wing air ambulances. In Scandinavian countries, the activation time for P-EMS is faster than that in Iceland, and, with the exception of Norway, the service areas are smaller.[15] This raises the question of whether the EQUIPE group's benchmarks are directly applicable to fixed-wing services, especially where bases are few and areas covered are vast, such as the Northwest Atlantic countries of Greenland, Iceland, and Faroe Islands.[16] This study did not aim to make a direct side-by-side comparison of fixed-wing air ambulance and HEMS. The EQUIPE QIs were not developed for helicopter services specifically, but for P-EMS. However, because the benchmarks are calculated based on data from helicopter and rapid response car services, some of the QIs will not necessarily have the external validity for a direct comparison between HEMS and fixed-wing air ambulance services. This is primarily the case for the time variables. For the other QIs, using the established benchmarks seems adequate due to similarities in setting. We assert that the same fundamental principles are applicable, the primary objective of any prehospital emergency service is to achieve optimal service levels, which encompass minimizing both response times and transport times, promote culture of safety and learning, and improve patient treatment through evidence-based medicine. In Iceland, where a HEMS is not available, a fixed-wing aircraft serves as the primary response unit for extensive regions characterized by limited infrastructure and restricted access to advanced emergency care. We found the EQUIPE QIs to be highly effective for identifying areas needing improvement.

The results indicate that there are numerous aspects of the Icelandic fixed-wing P-EMS that require enhancement. Some improvements, such as implementing formal post-mission debriefing and access to clinical guidelines, do not require significant funding or long time frames. However, some areas may require fundamental changes in the organization of the prehospital structure and its funding. Adding an extra airplane and crew could improve immediate availability and shorten the time to reach patients. In addition, placing a helicopter at a second location could provide better coverage and faster response times to many areas that are remote yet popular among tourists.[7] Ongoing research is investigating these options, but their implementation requires government commitment and a guaranteed increase in annual budget. Clearly defined and measurable goals for the service are necessary to meet the standards set by neighboring countries.

Strengths and Limitations

There are several limitations to this research, with the most prominent being the relatively small sample size. Although the vast majority of missions are flown by the fixed-wing air ambulances, the study's focus solely on this service excludes the National Coast Guard's helicopter service. This limitation prevents a comprehensive overview of Icelandic P-EMS air services, excluding search-and-rescue missions, and trauma or medical illnesses occurring in hard-to-reach places and at sea. As previously mentioned, we received 180 registration forms during the data collection period, although a physician was on board for 309 flights. Whether a physician was requested or present due to logistical reasons was not always noted. In cases for which a physician was onboard due to logistics, no registration form was required, potentially resulting in a response rate higher than 58%. To simplify the registration process, a QR code with a direct link to the questionnaire was sent to the flight physicians, enhancing participation. Although the number of regular flight physicians is small, allowing for relatively straightforward data follow-up, a few physicians filled short-term locum positions on the air ambulance. It remains unclear whether registrations were consistent during those periods.

The QIs were developed as a tool for facilitating quality improvement in the prehospital field by a panel of international experts and tested in Nordic physician-staffed HEMS for which the set of QIs was found to be applicable for measuring quality.[10,11] In the Icelandic setting, obtaining data for registering the QIs did not prove to be problematic, and no other problems regarding its use were reported by the participating physicians.

Most of the physicians in the Icelandic fixed-wing air ambulance service are anesthesiologists, similar to their Nordic counterparts, although a few have backgrounds in emergency medicine. The Icelandic prehospital health care system, however, has less of an infrastructure compared with other Nordic countries. There is only 1 fixed-wing base for the entire country, and it has limited resources in funding and staffing of qualified physicians. Electronic prehospital patient journals are not yet available, so there is a risk of information gathered during transport being lost. These systematic factors may also affect the quality of the service provided.

The Icelandic fixed-wing P-EMS cannot be directly compared with the Nordic helicopter P-EMS due to geographical and organizational differences. Thus, further testing and perhaps establishing different benchmarks for the subgroup of P-EMS in remote areas might be desired in the future. Regardless, the QIs proved to be a good tool for the Icelandic fixed-wing air ambulance to reflect on its services and find areas in need of improvement.

Conclusion

The QIs are useful as a tool for pointing out topics in the fixed-wing service that have room for improvement, and we believe that our results can guide both providers and policymakers in making informed decision to improve these services.

Declaration of competing interest

The authors have no relevant disclosures. There was no grant funding or financial support for this manuscript.

Appendix
Definitions of response-specific quality indicators.

Quality Indicator	Variables
1. Was the P-EMS unit able to respond immediately to the actual response?	Yes No
2. What is the time interval from the dispatch center receiving the alarm call until the P-EMS unit arriving at the patient's location?	Time in minutes
3. What is the time interval from the P-EMS unit's arrival at the patient's location until initiation of transportation of the patient?	Time in minutes
4. What is the time interval from the P-EMS unit receiving the alarm call until the delivery of the patient at the preferred destination?	Time in minutes
5. Did the patient arrive at the hospital alive?	Yes No Unknown Under ongoing CPR
6. Was the P-EMS response debriefed?	Yes, formal debriefing using checklist Yes, formal debriefing without using checklist Yes, informal debriefing No
7. Did you experience any adverse events during the P-EMS response?	Yes No
8. Are all defined key variables measured and documented in the patient chart?	Yes No
9. Did you have a guideline for the medical problem encountered in the response?	Yes No I do not know
10. Was a physician and/or paramedic from P-EMS involved in deciding if the P-EMS unit should be dispatched to the particular job or not?	Yes, physician/paramedic from P-EMS currently on call for P-EMS unit Yes, physician/paramedic from P-EMS on call in the Emergency Medical Communication Center Yes, physician/paramedic from P-EMS but not currently on call Unknown No
11. Without the assistance of the P-EMS unit, do you consider that the level of competence on the scene was sufficient to give the patient appropriate care? In the empty field, please indicate the highest level of care at the scene, apart from the P-EMS unit (another P-EMS physician, general practitioner, emergency medical service [ambulance], other).	Yes Probably Probably not No
12. Did P-EMS provide advanced treatment in the actual response?	Yes; procedures (medical and/or rescue techniques) or medications only offered by P-EMS units were used in the actual region Yes; procedures or medications also offered by other local prehospital units other than P-EMS were used, but these were NOT present on scene Yes; avoidance of unethical/unnecessary treatment Yes; presence in particularly demanding situations, for example, death of a child and major incidents No
13. Did the logistical contribution by P-EMS give the patient a significantly better service than the existing alternative?	Yes; by reducing the estimated time to admitting facility with ≥30 min for time critical conditions like STEMI, stroke, and severe trauma Yes; by reducing the estimated time to admitting facility with 15-29 min for time critical conditions like STEMI, stroke, and severe trauma Yes; by accessing and/or evacuating the patient from an area otherwise difficult to access Both 1 and 3 Both 2 and 3 No
14. Was the patient enrolled in a scientific study involving prehospital care?	Yes No I do not know
15. Did you ensure that relatives' needs were addressed, either by P-EMS or collaborating services?	Yes; their need for transportation to the admitting hospital Yes; their need for information and emotional or social assistance Yes; both 1 and 2 No; no time to inform relatives because of time-critical situation No; no relatives present on scene

CPR = cardiopulmonary resuscitation; P-EMS = physician-staffed emergency medical service; QI = quality indicator; STEMI = ST-elevation myocardial infarction.

CRediT authorship contribution statement

María Kristbjörg Árnadóttir: Writing – original draft, Investigation, Formal analysis. **Björn Gunnarsson:** Writing – review & editing, Conceptualization. **Helge Haugland:** Writing – review & editing.

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