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## Original Research

## Does Medical Staffing Influence Perceived Safety? An International Survey on Medical Crew Models in Helicopter Emergency Medical Services

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## A B S T R A C T

**Objective:** The competence, composition, and number of crewmembers have generally been considered to influence the degree of patient care and safety in helicopter emergency medical services (HEMS), but evidence to support the advantages of one crew concept over another is ambiguous; additionally, the benefit of physicians as crewmembers is still highly debated.

**Methods:** To compare perceived safety in different medical crew models, we surveyed international HEMS medical directors regarding the types of crew compositions their system currently used and their supportive rationales and to evaluate patient and flight safety within their services.

**Results:** Perceived patient and flight safety is higher when HEMS is staffed with a dual medical crew in the cabin. Tradition and scientific evidence are the most common reasons for the choice of medical crew. Most respondents would rather retain their current crew configuration, but some would prefer to add a physician or supplement the physician with an assistant in the cabin.

**Conclusion:** Our survey shows a wide variety of medical staffing models in HEMS and indicates that these differences are mainly related to medical competencies and the availability of an assistant in the medical cabin. The responses suggest that differences in medical staffing influence perceived flight and patient safety.

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Despite new treatment modalities in prehospital critical care,<sup>1</sup> the medical staffing model in helicopter emergency medical services (HEMS) has remained largely unchanged in many systems over the last 40 years. Additionally, the heterogeneity in medical staffing in HEMS is large, and systems with similar mission profiles may have very different medical crew compositions.<sup>2-6</sup>

Patient safety is the prevention of errors and adverse effects to patients associated with health care.<sup>7</sup> Transporting critically ill patients involves a significant risk of adverse events.<sup>8</sup> Although the number of reported incidents in air medical transports is low,<sup>9</sup> the

difference between the observed and self-rated performance of air ambulance clinicians may indicate that the problem is larger than the numbers reported.<sup>10-12</sup>

The competence, composition, and number of crewmembers may play a role in creating adequate redundancy in patient care to ensure patient safety, but supportive documentation regarding one crew configuration over another has thus far proven inconclusive. The benefit of including physicians in HEMS is highly debated.<sup>13-15</sup> Some studies have found that HEMS physicians contribute to improved survival,<sup>16,17</sup> whereas other studies showed no difference.<sup>18</sup> In trauma patients who were transported either with the combination of a flight nurse and a flight paramedic or with 2 flight nurses, the outcomes were also indistinguishable.<sup>19</sup> It has been suggested that it is the training and not the profession that is essential.<sup>20,21</sup>

The aim of this study was to describe the diversity of medical crew compositions currently used in HEMS and supportive

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rationales of these decisions. Our hypothesis is that the medical crew composition influences perceived patient and flight safety as reported by medical directors representing HEMS systems using different medical crew models.

## Material and Methods

### Questionnaire

Medical directors of HEMS in Europe, North America, Australia, New Zealand, and Japan were invited to participate in an HEMS Medical Crew Survey developed by 2 of the authors (K.R. and S.J.M.S.). This study region was chosen to include the entire spectrum of medical staffing models from well-established HEMS services. Before distribution, the questionnaire was tested on a number of HEMS professionals and revised according to their feedback. The Cronbach alpha for the 2 patient safety items and the 6 flight safety items was 0.943 and 0.952, respectively. The survey was distributed as a Web-based questionnaire (SurveyXact; Rambøll Management Consulting, Aarhus, Denmark).

To gather responses from a cross section of different crew models currently in use, participants were identified through the European HEMS and Air Ambulance Committee (EHAC), the European Prehospital Research Alliance (EUPHOREA), the Association of Critical Care Transport (ACCT), the Association of Air Medical Services (AAMS), the Aeromedical Society of Australasia (ASA) and the Emergency Medical Network of Helicopter and Hospital (HEM-Net). In North America, the invitations to participate in the survey were distributed through ACCT and AAMS, and in Japan through HEM-Net. In all other continents, the invitation was distributed directly. All invitations were sent via e-mail with a link creating a unique survey response. Two reminders were sent to all participants. All respondents were blinded to the researchers.

In the absence of a universally accepted definition of safety and a method of measuring the safety level, researchers in the oil industry have found “perception of risk” useful for understanding feelings of safety, attitudes to safety, risk-taking behavior, and accident involvement.<sup>22,23</sup> “Perception of flight safety” has been used as the primary outcome in HEMS research and was found to be significantly influenced by personal experience of a crash or serious incident.<sup>24</sup>

We asked the respondents to evaluate patient and flight safety during various mission types in their own service on a 7-point symmetric Likert scale, ranging from “totally unacceptable” (1), “unacceptable” (2), “slightly unacceptable” (3), and “neutral” (4) to “slightly acceptable” (5), “acceptable” (6), and “perfectly acceptable” (7).<sup>25</sup> Because we expected that medical directors respond favorably on their own systems as a sort of acquiescence bias or confirmation bias, negative or less positive scores were of interest because these responses probably represent a real negative attitude. This allowed us to dichotomize the responses and consider the difference between positive ratings (“acceptable” [6] or “perfectly acceptable” [7]) and less positive or negative ratings (“slightly acceptable” [5] or less) to be of particular clinical relevance.

To obtain the greatest degree of comparable data, respondents were asked to evaluate their program’s flight and patient safety based on the regular crew configuration used to operate under similar and, in this survey, poor weather conditions. A definition of “poor weather” was not given because this varies according to each HEMS operator’s procedures.

### Approval

The study was approved by the Data Protection Official for Research, Norwegian Social Science Data Services, Bergen, Norway (date of approval: April 23, 2014, ref. no. 38659), and was exempt from ethical approval by the Regional Ethical Committee of Western

Norway, Bergen, Norway (date of approval: April 20, 2014, ref. no. 2014/760).

### Definitions and Classifications

“One service” in this study is defined as the number of HEMS bases for which 1 medical director is responsible. Many professional titles are based on different regional educational models and lack universally approved definitions. Thus, for the questionnaire, we provided definitions for all relevant professional groups that can be found in an HEMS crew. “Medical competence” in this survey is defined as formal education and not level of experience.

We decided to regard physicians as 1 group despite differences in specialty and competence among systems. Studies have shown that airway management proficiency is similar in systems with the 2 most predominant specialties of HEMS physicians— anesthesiologists and emergency physicians.<sup>26-29</sup>

Registered nurses were defined as nurses with a bachelor’s degree or its equivalent and certified nurses as registered nurses with an additional certification examination. Nurse specialists, such as nurse anesthetists, intensive care nurses, and neonatal nurses, were defined as nurses with a college or a university education corresponding to a master’s degree.

Emergency medical technicians (EMTs) and paramedics were defined and categorized according to their airway skills (ie, basic [“only supraglottic airway devices”], intermediate [“endotracheal intubation but not rapid sequence induction” (RSI)], and advanced [“endotracheal intubation including RSI” and “may use a mechanical ventilator”]). This categorization was chosen because airway control has the highest treatment priority in emergency medicine, is considered the single most important factor for good outcomes,<sup>30,31</sup> and contributes to paramedics’ professional identity.<sup>32</sup>

In this study, crewmembers unavailable to assist the medical crew in patient treatment during flight were not included as part of the medical crew. Nurses and EMTs/paramedics with a combined role as a medical assistant and a pilot’s assistant during flight and obliged to sit in the cockpit under normal flight operations were categorized as an HEMS crewmember (HCM).

Services with variable staffing were categorized according to the staffing variation with the lowest level of medical education; for example, a crew staffed intermittently by paramedics or nurses was classified as paramedic staffed. Similarly, additional medical personnel used by demand, most often a physician, perfusionist, respiratory therapist, nurse, or midwife, were not counted as part of the regular crew in our analysis.

For the safety analysis, we assigned the responses into 6 groups according to the common denominators of the crew configuration; services with a single medical provider were compared with those with a dual medical provider configuration, services without a physician were compared with services with a physician, and services with a physician working alone were compared with those with a physician working with a medical assistant.

### Statistical Analysis

Dichotomous data are presented as counts and valid percents. Ordinal data are presented as medians and quartiles and visualized with box plots. Before analysis, we decided that a relevant break point was between “slightly acceptable” (5) and “acceptable” (6). Group differences of the Likert scale data dichotomized into the 2 groups Likert scale 1 to 5 and 6 to 7 were tested with the Fisher exact test using a significance level of  $P \leq .05$ . To our knowledge, no other studies exist with a comparable method or scale. We believe we have a good rationale behind the choice of break point and did not test others in search of significant results. All statistical analyses were performed using Microsoft Excel 2011 for Mac (Microsoft

Corporation, Redmond, WA) and SPSS Statistics for Mac (Version 22.0; IBM, Armonk, NY).

## Results

The survey was open between June 1 and October 15, 2014. A total of 113 responses were commenced. Of these, 2 submissions did not represent HEMS, 21 were incomplete on all parts of the survey, and 24 were excluded because of missing data on the core elements of the survey (ie, crew composition and evaluation of the crew concept). The remaining 66 submissions were eligible for analysis (Fig. 1). Geographically, the majority of responses originated

from Europe (17 from Scandinavia and 28 from the rest of Europe), with the remaining 21 from North America (17), Australia (3), and Japan (1). Each respondent represented from 1 to more than 10 HEMS bases. The participating services performed between 250 and 9,934 missions each in 2013, with a median of 1,007. The majority of services (84%) performed both primary missions (on-scene calls) and interhospital transfers; 11% performed only primary missions and 5% only transfers.

## Medical Personnel

Physicians were part of the crew in 48 services (73%), HCMs in 32 (48%), nurses in 31 (47%), EMTs/paramedics in 23 (35%), and a respiratory therapist in 2 (3%) services. Among the 48 services with physicians, 30 services (63%) used only board-certified specialists, whereas the remaining services also employed physicians-in-training. The most common specialty of the physicians was anesthesiology (85%) followed by emergency medicine (58%). Other specialties such as intensive care medicine, surgery, and internal medicine were less common. The majority of systems (60%) had physicians from multiple specialties in their crews, 27% had anesthesiologists only, 13% had emergency physicians only, and 10% had a combination of anesthesiologists and emergency physicians.

Of the 31 services with nurses, 25 (81%) required additional specialty training, most commonly as certified nurses. The most common certifications were certified flight nurse, certified emergency nurse, or certified critical care nurse (Table 1).

EMTs and paramedics were certified in advanced airway skills (RSI) in 13 (59%) of the 22 services responding to this question, intermediate skills (intubation but not RSI) in 6 services (27%), and basic airway skills (supraglottic airways only) in 3 services (14%) (Table 1). The medical training of the HCMs varied between training as a nurse in 13 services (41%) and EMTs or paramedics in 28 services (88%) (Table 1).

The respondents in this survey represented a variety of different medical staffing combinations. The 3 most common models were physician and HCM (38%), physician and nurse (20%), and nurse and EMT/paramedic (17%). Physicians were single medical care providers in 26 services and had assistants in 22 services. Nurses were single providers in 2 services and had assistants in 13 services.

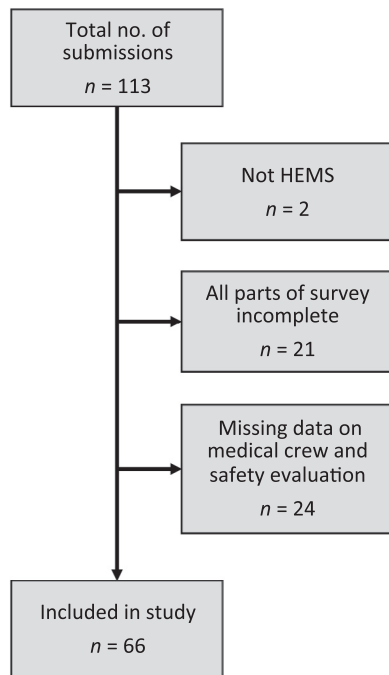


Figure 1. The inclusion flowchart.

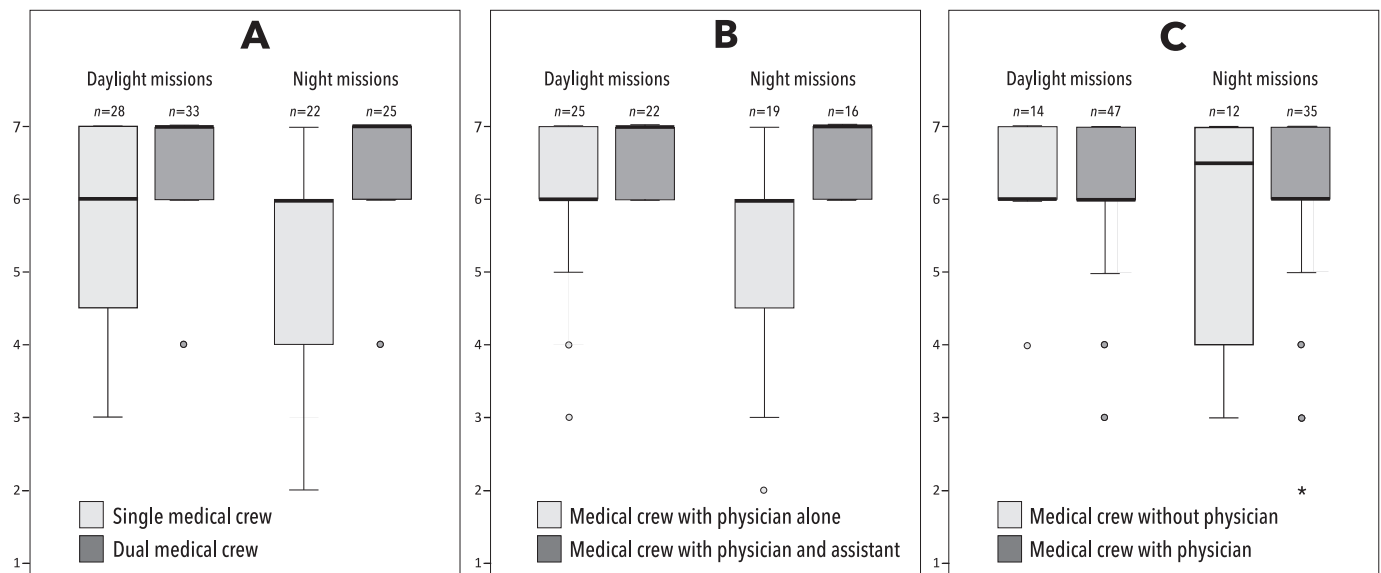


Figure 2. Respondents' perceived patient safety in HEMS daylight and night missions for (A) single and dual medical crews, (B) crews with a physician alone and a physician with a medical assistant, and (C) crews without and with a physician rated from "totally unacceptable" (1) to "perfectly acceptable" (7).

**Table 1**  
The Distribution of Medical Training (Counts) for Nurses, Emergency Medical Technicians (EMTs)/Paramedics (PMs), and Helicopter Emergency Medical Service Crewmembers (HCMs)

Medical Training	Nurses' training (n = 31)	EMTs/PMs' training (n = 23)	HCMs' training (n = 32)
Certified nurse	62		2
Nurse specialist	17		4
Registered nurse	6		7
EMT/PM with advanced airway skills		13	8
EMT/PM with intermediate airway skills		6	10
EMT/PM with basic airway skills		3	10

Advanced airway skills include rapid sequence intubation (RSI), intermediate airway skills include intubation but not RSI, and basic airway skills include the supraglottic airway only. The total number may exceed the number of services (n) because 1 service may have personnel with different training. One service with EMTs/PMs did not provide information on medical training.

Paramedic-led services were rare; only 2 used a paramedic alone, and 1 service operated with a paramedic and an assistant. Overall, 30 (45%) services had a single medical provider and 36 (55%) a dual medical crewmember configuration.

**Evaluation of Safety**

**Patient Safety**

Systems with a single crewmember in the cabin generally assigned lower scores for patient safety during night missions than for daytime missions and had significantly fewer respondents with perceived patient safety "acceptable or better" for both night and daytime missions when compared with systems with an assistant in the cabin. The significantly lower scores for the single crew compared with those of dual crews were also present when a physician was part of the crew; however, differences between crews with and without a physician on board were negligible (Fig. 2, Table 2).

**Flight Safety**

Single medical crew services generally assigned lower scores for perceived flight safety to all flight operations with a patient on board compared with dual medical crew systems, with significantly fewer respondents with a perceived flight safety of "acceptable or better" (Fig. 3A, Table 2). The same tendency was found when comparing single and dual medical crews with a physician; dual medical crews with physicians had the highest scores for flight safety (Fig. 3B, Table 2). Flight safety was given a nonsignificantly higher score in systems with a physician in the crew compared with services without a physician on board (Fig. 3C, Table 2). No differences in perceived flight safety were found for any group comparison for flights without a patient on board.

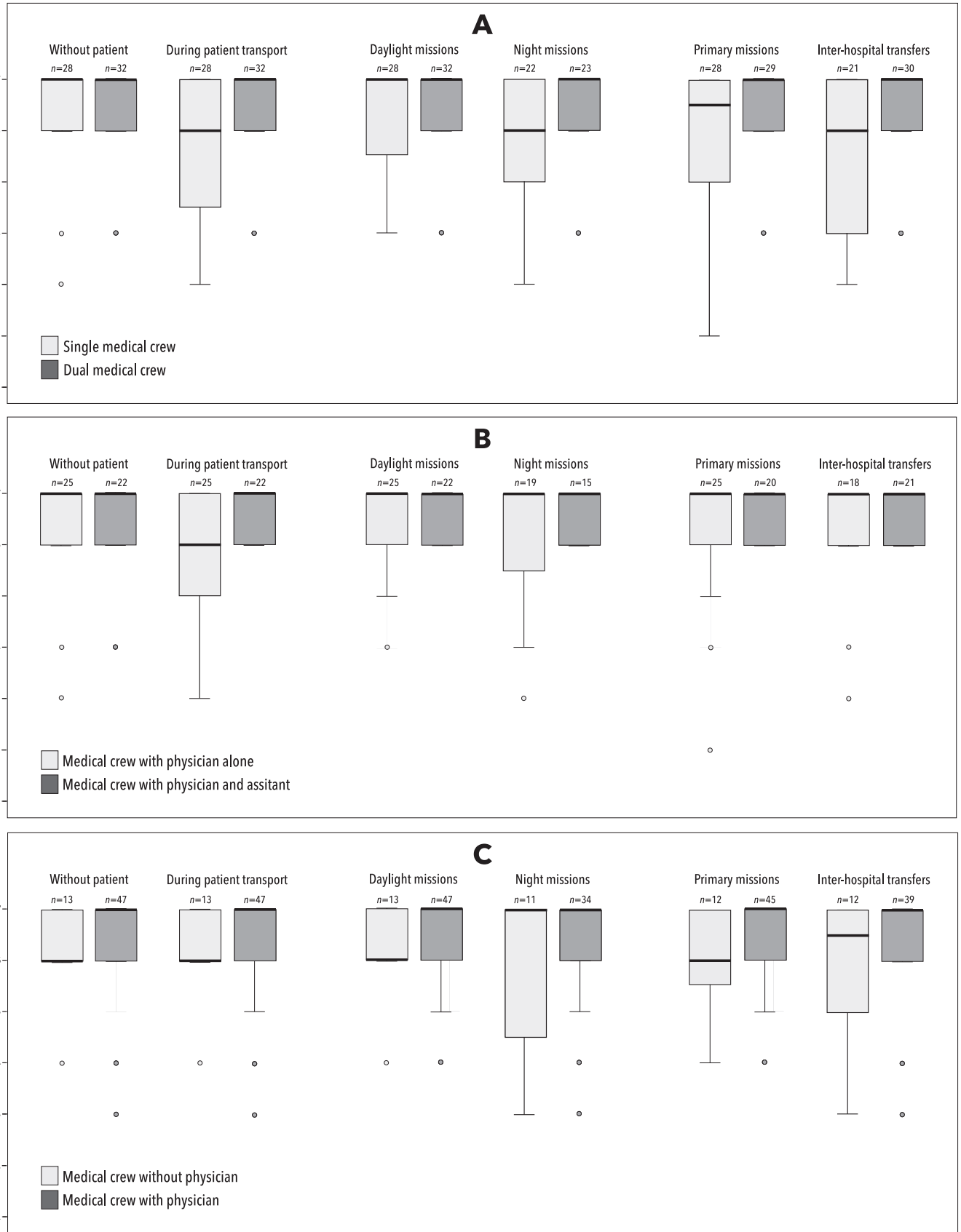
**Reasons for Choice of Medical Crew Model**

Sixty-two respondents provided their 3 most important reasons for choosing their current medical crew concept. Overall, the most common reasons given were tradition and scientific evidence followed by aircraft configuration, company politics, and economic reasons (Table 3). Tradition and aircraft configuration were the 2 most common reasons for choosing a single crew. Scientific evidence was a more frequent reason provided for having a crew without a physician compared with that with a physician, as well as for choosing a dual medical crew compared with a single medical crew. Economic reasons were not common in systems without physicians in their crews, but they were more often assigned as a reason for choosing a single crew model compared with a dual crew.

**Table 2**  
The Number of Observations (n), Medians, and Quartiles for All Subgroups and the Percentage of Observations With Perceived Safety "Acceptable" or Better

	1 Medical Crewmember			2 Medical Crewmembers			A Physician as Only Medical Crewmember			B Physician With Medical Assistant			C No Physician in the Crew			Physician in the crew				
	n	Median (Q1, Q3)	% 6-7	n	Median (Q1, Q3)	% 6-7	n	Median (Q1, Q3)	% 6-7	n	Median (Q1, Q3)	% 6-7	n	Median (Q1, Q3)	% 6-7	n	Median (Q1, Q3)	% 6-7	P Value	
<b>Patient safety</b>																				
Daylight missions	28	6.0 (4.5, 7.0)	71	33	7.0 (6.0, 7.0)	97	25	6.0 (6.0, 7.0)	76	22	7.0 (6.0, 7.0)	100	14	6.0 (6.0, 7.0)	79	47	6.0 (6.0, 7.0)	87	.416	
Night missions	22	6.0 (4.0, 6.0)	55	25	7.0 (6.0, 7.0)	96	19	6.0 (4.5, 6.0)	63	16	7.0 (6.0, 7.0)	100	12	6.5 (4.0, 6.0)	67	35	6.0 (6.0, 7.0)	80	.435	
<b>Flight safety</b>																				
Flight without patient	28	7.0 (6.0, 7.0)	79	32	7.0 (6.0, 7.0)	94	25	7.0 (6.0, 7.0)	84	22	7.0 (6.0, 7.0)	96	13	6.0 (6.0, 7.0)	77	47	7.0 (6.0, 7.0)	89	.353	
During patient transport	28	6.0 (4.5, 7.0)	68	32	7.0 (6.0, 7.0)	97	25	6.0 (5.0, 7.0)	72	22	7.0 (6.0, 7.0)	100	13	6.0 (6.0, 7.0)	77	47	7.0 (6.0, 7.0)	85	.675	
Daylight missions	28	7.0 (5.5, 7.0)	75	32	7.0 (6.0, 7.0)	97	25	7.0 (6.0, 7.0)	80	22	7.0 (6.0, 7.0)	100	13	6.0 (6.0, 7.0)	77	47	7.0 (6.0, 7.0)	89	.353	
Night missions	22	6.0 (5.0, 7.0)	64	23	7.0 (6.0, 7.0)	96	19	7.0 (5.5, 7.0)	74	15	7.0 (6.0, 7.0)	100	11	6.0 (4.5, 7.0)	64	34	7.0 (6.0, 7.0)	85	.190	
Primary missions	28	6.5 (5.0, 7.0)	71	29	7.0 (6.0, 7.0)	97	25	7.0 (6.0, 7.0)	76	20	7.0 (6.0, 7.0)	100	12	6.0 (5.5, 7.0)	75	45	7.0 (6.0, 7.0)	87	.380	
Interhospital transfers	21	6.0 (4.0, 7.0)	71	30	7.0 (6.0, 7.0)	97	18	7.0 (6.0, 7.0)	78	21	7.0 (6.0, 7.0)	100	12	6.5 (5.0, 7.0)	75	39	7.0 (6.0, 7.0)	90	.334	

P values from the Fisher exact test comparing perceived safety in the dichotomized groups (Likert scale 1-5 vs. 6-7) for (A) single and dual medical crews, (B) crews with a physician alone and with an assistant, and (C) crews without and with a physician for each type of mission.



**Figure 3.** Respondents' perceived flight safety in HEMS missions for (A) single and dual medical crews, (B) crews with a physician alone and a physician with a medical assistant, and (C) crews without and with a physician rated from "totally unacceptable" (1) to "perfectly acceptable" (7).

**Table 3**  
The Total Count of the Respondents (N = 62) Regarding the 3 Most Important Reasons for Their System's Medical Staffing

	Total Number of Responses	Tradition	Scientific Evidence	Aircraft Configuration	Company Politics	Economics	Recruitment of Special Personnel	Governmental Politics	Legal Issues
Overall	186	33	30	26	26	26	17	14	14
Single	84	20	6	17	13	14	5	4	5
Dual	102	13	24	9	13	12	12	10	9
DocAlone	75	17	5	16	11	13	5	3	5
DocAssist	66	8	14	7	11	7	6	9	4
Doc	141	25	19	23	22	20	11	12	9
NoDoc	45	8	11	3	4	6	6	2	5

Doc = a physician in the crew; DocAlone = a physician as the only medical crewmember; DocAssist = a physician with a medical assistant; Dual = 2 medical crewmembers; NoDoc = no physician in the crew; Single = only 1 medical crewmember.

**Table 4**  
Contingency Table of Respondents' Actual Medical Staffing Versus Preferred Medical Staffing

		Preferred Medical Staffing						Total
		DocAssist	DocAlone	NurseAssist	NurseAlone	ParamAssist	ParamAlone	
Actual medical staffing	DocAssist	21		1				22
	DocAlone	9	16					25
	NurseAssist	3		8				11
	NurseAlone	1			1			2
	ParamAssist	1				0		1
	ParamAlone	1					0	1
	Total	36	16	9	1	0	0	62

DocAlone = a physician as the only medical crewmember; DocAssist = a physician with a medical assistant; NurseAlone = nurse as the only medical crewmember; NurseAssist = a nurse with a medical assistant; ParamAlone = paramedic as the only medical crewmember; ParamAssist = paramedic with a medical assistant. Four respondents were excluded because they indicated no preferred medical staffing.

### Preferred Medical Staffing

Sixty-two of the 66 respondents shared their opinion of what they considered to be the optimal medical crew configuration if allowed to choose freely. Of these, 46 (74%) opted to keep their current crew configuration and staffing (Table 4). Of the 47 systems with a physician in the crew, only 1 would have omitted the physician. In contrast, 6 of the 15 systems without a physician in their crew would have preferred to have one. Nine of 25 systems with a physician as the single medical crewmember would have preferred to add an assistant to the crew, and none of the systems with a physician and an assistant in the crew would omit the assistant.

### Discussion

The results from this survey indicate that perceived patient and flight safety is higher when HEMS crews are staffed with a dual medical crew than with a single medical crew. A higher degree of perceived safety was also noted when a physician was part of this crew. Tradition and scientific evidence are the most common reasons for choosing a specific type of medical crew model, whereas economic reasons are less common. Most respondents would not change their crew configuration, but some would prefer to add a physician to the crew or supplement the physician with an assistant in the cabin.

Human resources and medical staffing seem to have a direct influence on patient safety.<sup>33</sup> Studies from other high-complexity domains of health care, such as intensive care medicine and emergency medicine in the emergency department, show that errors occur frequently because of the high complexity of care and patients' conditions.<sup>34,35</sup> Increased redundancy could be achieved through a higher health care provider-to-patient ratio. Our survey suggests that HEMS systems with a single medical staff in the cabin would prefer a dual medical crew to ensure improved safety.

Medical staffing models should not have a negative impact on flight safety. However, our study suggests that some HEMS systems are concerned with flight safety in certain staffing models. Dual

medical crews seemed more preferable; this might be explained by the higher vigilance and ability to distribute the workload in a dual medical crew. Without patients on board, a single medical crewmember can contribute to the flight operations, but during patient transport, the focus must be on the patient.

Scientific evidence was high on the list of reasons provided for choosing a specific medical crew model. This is interesting, considering the lack of unambiguous scientific evidence in support of one crew configuration over another. The debate regarding whether to involve physicians in HEMS is still unresolved,<sup>14-16</sup> although several studies support staffing HEMS with physicians.<sup>17,36-38</sup> In Europe, this is a well-established concept, with the debate primarily regarding which specialty and training the physician should have.<sup>39-41</sup>

### Limitations

We asked the respondents for their perception of flight and patient safety. Even though perception of risk has been found useful for safety research in the oil industry<sup>22,23</sup> and in HEMS for the evaluation of flight safety,<sup>24</sup> it is still a subjective assessment with all the limitations that this involves and must be interpreted accordingly. We did not provide a specific definition of the 2 safety concepts because we think they are commonly associated with the same interpretation in the HEMS community. A more specific definition and limitation of the safety concepts could also have limited some of the responses in which the safety concepts were interpreted in a broader context.

Alternatively, we could have asked for specific numbers of adverse events or errors reported in the different services, but we feared the quality of these reports would have been poor and difficult to compare because there are differences in definitions of what adverse events, near misses, and errors are. They may also only reflect different reporting cultures and not the true level of safety.

Because of confidentiality restrictions in some organizations, we did not gain access to the total number of HEMS systems eligible for participation. Although this precludes us from evaluating the

response rate and the representativeness of this sample of all HEMS, we believe that we achieved a sample of the most common medical crew models currently used in HEMS. The survey was blinded, so we cannot confirm that the respondents were actually medical directors. The perception of flight and patient safety may depend on whether the respondent participated in active service or not and may be prone to responder bias as a result of the respondents' economic or emotional conflict of interest with the HEMS operator. Therefore, the reported attitude toward safety issues may be overconfident.

### Future Studies

The findings of our survey confirm the diversity in medical crew staffing in HEMS and the inconsistency of scientific arguments for choosing one medical crew model over another. Our findings indicate that different crew configurations may have different effects on flight and patient safety. Therefore, future studies should attempt to isolate the effect of different medical crew models on patient safety and flight safety in an experimental scenario.

### Conclusion

In our survey, HEMS crews with a dual medical crew and crews with physicians and an assistant in the medical cabin scored highest in perceived patient safety among medical directors. The differences in medical HEMS crew concepts are mainly related to medical competence in the crew and the availability of an assistant in the medical cabin. According to the medical directors in HEMS, the rationale behind different medical crew concepts is mostly founded on tradition and scientific evidence and not economy. Future studies must confirm if the perceived patient safety challenges related to medical crew composition are quantifiable and relevant to all types of HEMS missions.

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### Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.amj.2017.09.008>.

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