Safety of helicopter aeromedical transport in Australia: a retrospective study

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ABSTRACT

Objectives: To determine the accident rate for Australian helicopter emergency medical services (HEMS) per 100 000 flying hours and to determine the patient mortality risk per mission from a HEMS accident.

Method: Retrospective observational study of Australian HEMS flying hours and accidents from 1992–2002.

Results: The calculated accident rate for Australian HEMS is 4.38 per 100 000 flying hours. One patient died as a direct result of helicopter accident in 50 164 missions. Overall, one accident occurred every 16 721 missions.

Conclusions: The overall Australian HEMS accident rate is similar to that reported from other countries, with all accidents occurring in Queensland community HEMS. Helicopters flown at night under Visual Flight Rules (VFR) appear to represent a high-risk subgroup. HEMS flights do not appear to present significant mortality risk to patients being transported.

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The first Australian helicopter emergency medical service (HEMS) began operations in Sydney in 1973. Since then, HEMS operations within Australia have grown considerably (see Box 1). HEMS programs now operate in all Australian states and territories except the Northern Territory.

Benefits in morbidity and mortality have been reported with physician-staffed HEMS stabilisation and primary transport of trauma patients;[1-3] however, the benefits for trauma patients[4,5] as well as medical patients[6-10] have been challenged. It is generally accepted in medicine that the risk of an intervention should not be greater than its demonstrated benefit. Unless the risk is known, it is impossible to realistically assess the risk–benefit of HEMS.

To date, there has been no attempt to quantify the risks associated with HEMS operations in Australia. This article attempts to define the accident rate for HEMS operations and the patient mortality risk from a HEMS accident within Australia.

METHODS

Australian HEMS operators listed in the "SAR, EMS and Police Directory"[11] were contacted by mail, email and telephone, and asked to provide the following data for the period 1 January 1992 to 31 December 2002:

- the number of medical missions (primary and interhospital) flown,
- the number of patients transported, and
- the total number of flying hours engaged in (primary and interhospital) patient transport.

Discussions with the listed HEMS operators and state ambulance services identified other users of helicopters for medical transport, such as the Northern Territory Aerial Service, and government agencies such as Queensland Emergency Services, who were then contacted and asked to provide the same data. Ad-hoc patient transports by commercial (non-HEMS) helicopter operators, as occurred in the Australian Capital Territory, Western Australia and the Northern Territory during the study period, were excluded.

When the number of patient transports and the number of missions were not both reported, we assumed one patient transport per mission and vice versa.

The number of accidents involving EMS helicopters during the same period was determined from Air Safety Occurrence Reports published by the aviation branch of the Australian Transport Safety Bureau. HEMS air-safety occurrences not associated with usual primary or interhospital patient transports, such as winch (hoist) operations and "search and rescue" missions, were excluded.

Aviation accident rates are reported as fatal and total accidents per 100 000 flying hours.[12-15] Data were collated and entered onto a standard spreadsheet format. The accident rate (per 100 000 flying hours) and patient mortality rate per mission were then calculated.

The study was approved by the chairman of the Townsville Hospital and District Ethics Committee.

RESULTS

We received data for all HEMS operations in Australia during the study period, with the exception of one Victorian community service provider who commenced operations in mid-1999.

The numbers of missions, patients transported, flying hours and accidents for each year of the study period are shown in Box 1. A summary of HEMS activity by state is shown in Box 2. Calculated accident rates per 100 000 flying hours for Australia, Queensland government HEMS, and Queensland community HEMS are shown in Box 3. Published rates for the United States and the Federal Republic of Germany are included in Box 3 for comparison. The number of patients transported is generally less than the total number of missions. This is most likely because of missions being aborted or patients dying before transport.

In Australia during the study period, only one patient, a 5-year-old boy, died as a direct result of a HEMS accident in 50 164 missions. He was accompanied by his mother, who also suffered fatal injuries in the crash, as did the pilot and two paramedics.[18] Over-

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1 Australian helicopter emergency medical services, 1992–2002

Year	Missions	Patients	Flying hours	Accidents
1992	1 278	1 278	1 707	0
1993	1 755	1 755	2 423	1
1994	1 809	1 769	2 882	0
1995	2 213	2 199	3 233	0
1996	3 637	3 609	4 784	0
1997	4 364	4 343	5 567	1
1998	5 838	5 838	7 962	0
1999	6 817	6 526	9 057	0
2000	7 582	7 257	10 347	1
2001	7 303	6 907	10 170	0
2002	7 568	6 982	10 303	0
Total	50 164	48 463	68 435	3

2 Australian helicopter emergency medical services activity, by state, 1992–2002

	Missions	Patients	Flying hours	Accidents
NSW	21 336	21 336	32 421	0
QLD	16 899	16 795	23 199	3
VIC	9 524	7 829	8 720	0
SA	1 982	2 080	3 164	0
TAS	423	423	931	0
Total	50 164	48 463	68 435	3

all, one accident occurred every 16 721 missions. A summary of Australian HEMS accidents that occurred during the study period is provided in Box 4.[18-20]

Following the study period, another Queensland Community Rescue Service helicopter crashed into the sea north of Mackay, killing all three crew members. This occurred during a night flight to collect an injured patient on Hamilton Island.[21] Details of this accident are also included in Box 4.

DISCUSSION

The accident rate for HEMS in Australia is 4.38 per 100 000 flying hours for the period 1992–2002, which is similar to the reported international experience. All accidents within the study period involved Queensland community HEMS flying under Visual Flight Rules. Their accident rate was 25.03 per 100 000 flying hours, based on three accidents in 11 987 flying hours. During the same period, other HEMS operations in Australia accumulated a total of 56 448 accident-free flying hours. It is important to note that our data do not allow comparison of accident rates between Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) HEMS flying hours (see Box 4 for definitions). It should also be noted that VFR HEMS operations are conducted in other parts of Australia — they are not limited to Queensland community HEMS.

3 Comparison of accident rates for different helicopter emergency medical services

Helicopter emergency medical service	Period	Missions	Patients transported	Flying hours	Accident rate per 100 000 flying hours	
					Fatal	Total
Australia (total)	1992–2002	50 164	48 463	68 435	1.46	4.38
Australia (excluding QLD)	1992–2002	33 265	31 668	45 236	0.00	0.00
QLD government	1992–2002	8 532	8 532	11 212	0.00	0.00
QLD community	1992–2002	8 367	8 263	11 987	8.34	25.03
United States[16]	1982–1987	Not available			4.7	11.7
Germany[16]	1982–1987	Not available			4.1	10.9
United States[17]	1992–2001	Not available			1.69	4.83

It has been stated that helicopter transport is expensive and risky, and that the benefits of helicopter transport must always be weighed against the risk of death for patients.[22] The overall risk of accident-related patient death in Australia is about 1 in 50 000 HEMS missions. It is not known how this risk compares to other modes of patient transport, such as road ambulance or aeroplane, and further research is required in this area. Clinicians requesting patient transport should always consider whether any potential benefit to the patient is greater than the risk of the transport itself.

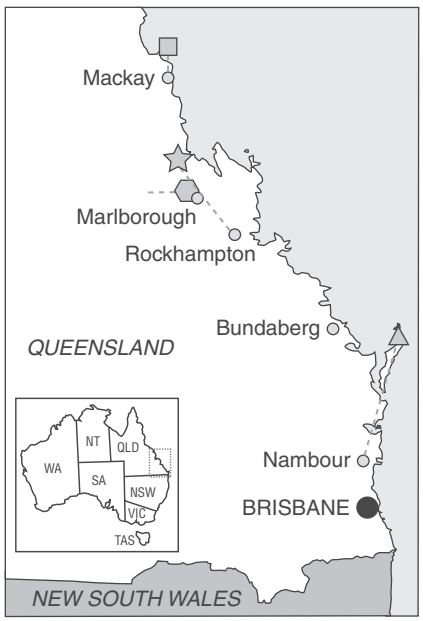
Our data underestimate the number of HEMS missions, patients transported and hours flown, because one Australian HEMS operator did not provide data for the study period, and we did not include ad hoc patient transports by general aviation helicopter operators. Thus, our calculated accident rate will be higher than the actual rate. We believe this is unlikely to significantly affect our results. For example, correcting for an underestimation of flying hours by 5% would change the Australian HEMS accident rate from 4.38 to 4.19 per 100 000 flying hours.

Another potential confounding variable is the assumption that one patient was transported per mission and vice versa when either of the variables was unknown. Several HEMS operators stated informally that it is unusual to transport more than one patient per mission. The effect of this potential error on the calculated "patient mortality per mission flown" is unknown.

All air safety occurrences require mandatory reporting to the Air Transport Safety Bureau. We are therefore confident that all HEMS-related accidents occurring during the study period have been identified. Our study attempts to define risk associated with standard primary and interhospital patient transfers. We specifically excluded HEMS flying hours and air-safety occurrences not associated with standard transports, such as aerial winch (hoist) and "search and rescue" operations. We believe that such operations do not reflect the procedure and risk encountered with standard HEMS transport, and require separate risk assessment.

Investigation of reasons for the high accident rate experienced by Queensland community HEMS is beyond the scope of this article and warrants further review. However, we note that three of the four HEMS accidents since 1992 (including one accident after our study period) occurred during night VFR flight in single-engine helicopters flown by a single pilot. Spatial disorientation at night or inadvertent flight into non-VFR weather conditions is thought to have been a major contributor in these accidents.[18,19,21] A 2002 review of HEMS safety in the US by the Air Medical Physician Association[17] reported that a disproportionate number of accidents occur at night, and during "on scene" transports (primary retrievals). They also noted that more than 85% of weather-related HEMS

4 Summary of HEMS accidents in Australia, 1992–2003[18-21]



17 October 2003, 21:40.
28 km north of Mackay QLD
Night VFR. En route to Hamilton Island.
High-speed impact into the sea.
Three fatalities, aircraft destroyed.
This accident occurred after the study period.

2 May 1997, 12:30.
Tartrus Station, QLD
Day VFR. After landing at scene an explosion occurred while an oxygen cylinder valve was being opened.
One person seriously injured. Aircraft caught fire and was destroyed.

24 July 2000, 02:07
1 km north-west of Marlborough, QLD
Night VFR. Returning to Marlborough from Yarandoo Station.
Entered thick fog, impacted ground 300 m from intended landing point.
Five fatalities. Aircraft destroyed.

12 May 1993, 20:20
North Fraser Island, QLD
Night VFR. On descent to destination, entered heavy rain. Descended into trees 400 m short of intended landing point.
No injuries. Substantial damage to aircraft.

VFR = Visual Flight Rules: the helicopter is principally flown and navigated by visual reference to ground features. The pilot must be able to see at least 5 km and maintain 1.5 km horizontal and 1000 feet vertical separation from cloud. This may be reduced in some circumstances for helicopters so that the pilot only has to be able to see 800 m and remain clear of cloud. When flight cannot be conducted under VFR, then Instrument Flight Rules (IFR) apply, with the aircraft principally flown and navigated by reference to the aircraft instruments and avionics. Not all aircraft are equipped for IFR.

accidents occurred at night. Our observations appear to be consistent with international experience, and we believe that patient transport by VFR helicopters in inclement weather or at night cannot be supported.

One of the major difficulties encountered in this study was that Australia does not have a centralised compulsory reporting system for HEMS flying hours and for the number of patients transported. This makes accurate assessment of HEMS accident rates and patient risk difficult. We recommend establishment of a centralised national database as a means of monitoring HEMS activity and safety.

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