Air Medical Journal 38 (2019) 183–187

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Original Research

Assessing Lift-Off Times for a Hospital-Based Helicopter Transport Program

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A B S T R A C T

Objective: Hospital-based helicopter transport programs must define and track their own lift-off times (LOTs). The goal of this quality improvement study was to evaluate LOTs, identify factors influencing LOTs, and implement changes to improve LOTs without compromising safety.
Methods: A retrospective evaluation of 248 flights during 2016 was completed using recorded times from our dispatch center. Actual LOTs were compared with policy LOT goals. Tasks for flight departure were identified, timed, and sorted into those that should not be pressured and those amenable to process change.
Results: Five tasks were identified as being amenable to process change. The average LOT for scene calls was 10.56 minutes (range, 1-22 minutes) and met our 10-minute policy goal 59% of the time. The average LOT for interfacility flights was 13.2 minutes (range, 4-76 minutes) and met the policy goal of 15 minutes 76.5% of the time.
Conclusion: We identified tasks amenable to safe process change to decrease LOTs. The data supported LOT policy change to a single LOT goal of 13 minutes for all flights. This change represents an acceptable goal for all LOTs without compromising safety to our patients and teams.

Time-critical conditions such as myocardial infarction and ischemic stroke can require rapid transport to definitive care to optimize outcomes. Helicopter emergency medical services can play a vital role in meeting time-sensitive reperfusion goals in these conditions. Lift-off time (LOT) can influence time-sensitive conditions, and very little is known about acceptable standards for LOTs or factors influencing these times. Flight services transport patients with many time-critical conditions, and a multitude of studies show improved benefit and health outcomes when time to medication or intervention is reduced. For example, Menon et al[1] noted that in patients with ischemic stroke, each 30-minute delay between obtaining a head computed tomographic scan and reperfusion using thrombectomy indicated a decreased functional independent outcome. Meretoja et al[2] studied ischemic stroke treatment using intravenous thrombolysis, finding 2 significant outcomes affected by treatment delays. The first was that patients achieved an average of 1.8 additional days of healthy life for each minute saved between symptom onset to treatment time. The second finding was that a 15-minute decrease in onset to treatment time equated to an additional 1 month of life without disability.[2] Time is also critical with patients experiencing ST-elevation myocardial infarction (STEMI). Ward et al[3] studied the timeliness of interfacility (IF) transfer for emergency department patients with STEMI. In their cohort of transferring emergency departments caring for patients with STEMI, they noted delays and variability in transfer times after obtaining electrocardiograms. They further noted that factors affecting reperfusion and transportation in this patient population should be addressed and reduced, if possible.[3] Minutes count.

An extensive literature review failed to reveal any national standard for LOTs. The Air Medical Physician Association's Principles and Direction of Air Medical Transport[4] does not state a specific LOT goal as a

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1067-991X/$36.00

https://doi.org/10.1016/j.amj.2018.12.001

Table 1

Minutes	10	11	12	13	14	15	16	17	18	19	20
Predicted Success	33.5%	42.4%	51.4%	60.5%	69.1%	76.7%	83.1%	88.3%	92.2%	95.1%	97.0%

standard. However, it does state that an LOT should be recorded for each flight. It further recommends against publicizing LOTs in general because it can put undue pressure on the pilots and medical crews to meet the public's perception of an overall response time. Likewise, the Commission on Accreditation of Medical Transport Systems (CAMTS) 10th edition standards[5] were reviewed; however, no LOT standard was found. Correspondence with the CAMTS executive director explained that CAMTS intentionally does not have an LOT standard because of variations in programs; therefore, programs should decide what is reasonable for their location. Finally, the Association of Air Medical Services does not reference or promote a national LOT standard on their member website or in written literature. In a National Emergency Medical Services Pilots Association AIRNET newsletter dated March 20, 2008, Rex J. Alexander addressed the topic of launch times and influencing factors. It was pointed out that no one size fits all, that launch times are task driven and not time driven, and that programs should develop a list for all necessary tasks before liftoff.[6]

Many HEMS requests have an unknown time-dependent component, and, therefore, having a consistent time-sensitive LOT metric can become important when limited preflight information is known. We undertook this quality improvement study to evaluate our LOT goals and determine if they were realistic within the constraints of our system. We also wished to determine whether more than one LOT was needed. At the initiation of this study, our program had a 10-minute LOT goal for scene (SC) flights and a 15-minute LOT goal for interfacility (IF) flights with a goal metric of meeting each LOT 75% of the time.[7] These times were not based on tasks; thus, we believed it was essential to develop a rubric for measurement and provide objective guidance to LOT metrics. Properly determined LOT goals that embrace the needs of patients with time-critical conditions without placing unreasonable pressure on teams will guide internal system improvements while maintaining patient and crew safety.

Methods

A retrospective analysis of all flights performed by our service during the calendar year 2016 was completed. Times were pulled from our dispatch recording system (Golden Hour Live, San Diego, CA). A total of 299 flights occurred during this study. Of these, 50 flights were excluded because of patient transports starting at the helicopter base's hospital. In short, no LOT was recorded because of the patient and helicopter being at the same location when the flight request was accepted; therefore, patient assessment and packaging took place before departure, resulting in inaccurate data. One additional flight was removed because of the flight request for a long-distance transport coming at a time that exceeded the pilot duty day. This imposed a delay in departure until the oncoming pilot could arrive at the base. The remaining 248 flights were separated into 2 categories, IF (n = 168) and SC (n = 80) flights, consistent with the current policy at the time of our study. LOT is defined as the time from which a flight request is made until the helicopter lifts into the air en route to the patient location. At the time of the study, the program was dispatched in 1 center, and operational control was at a second dispatch center, requiring contact with both centers before departure on a flight.

To characterize LOTs, means and variances were calculated overall and for both the IF and SC groups. Times were plotted by calendar month, including a smooth mean estimate with 95% confidence limits overall and for both the IF and SC groups. To compare the mean LOT between the IF and SC groups, a linear model was applied, including LOT as the outcome and the IF/SC group as the predictor of interest and controlling for month.

In order to predict the percent of instances in which common LOT cutoffs were reached, LOTs were evaluated for normality using the Anderson-Darling test. Assuming normality with the observed mean and variance, the percent of observations expected to fall within the given cutoffs was estimated. Based on the observed times, the mean and variance of LOTs were estimated. Predictions were made for how often we would expect to see future LOT goals met. For example, a 15-minute LOT was predicted to be met 76.7% of the time (Table 1).

A task list for liftoff was collaboratively compiled involving management, pilots, nurses, paramedics, and mechanics (Table 2). Once this list was compiled, the task list was separated into 3 categories: tasks that could be timed and did not present a safety issue, tasks

Table 2
Liftoff (LOT) Task List

#	Task	Comment
1	Flight request	Dispatched from remote call center
2	Call to pilot	Dispatch center calls pilot: *when LOT begins*
3	Pilot checks weather	Weather check at several locations: home base, destination, locations en route
4	Pilot contacts medical crew	Team discussion ensues to accept or decline flight: “Three to go, one to say ‘no’ policy”
5	Restroom break	All involved agree this should not be timed, but needed to be included
6	Walk to aircraft	Crew quarters in distant location from aircraft (~1/4-mile walk)
7	Sleep inertia	Pilot alertness assessed; if necessary, delay departure to allow for full wakefulness of pilot
8	Contact OCC with flight plan	Phone call from pilot to OCC
9	Medical crew gathers needed supplies	For example, blood, fetal monitors, balloon pumps, etc
10	Remove blade covers	Performed by medical crew
11	Unplug aircraft from charger	This charges onboard medical devices, medical crew
12	Remove climate control device	Performed by medical crew
13	For low-light conditions, gather night vision googles	These are regulated by the Federal Bureau of Investigation and in a locked safe; obtained by all 3 crewmembers
14	Pilot to complete preflight risk assessment	
15	Await confirmation from OCC regarding risk assessment	Pilot receives text confirming flight approval
16	Perform walk-around inspection of aircraft	All 3 crewmembers perform
17	Pilot completes start-up checklist	Confirms area is clear and crew is ready to start engine
18	Aircraft start-up	Approximately 30 seconds for all radios, GPS to be functioning
19	Standardized REACH start-up/departure checklist	Verbally reviewed with all crewmembers confirming doors, seat belts, etc. are all safe and ready for departure

OCC = operational control center.

Table 3

#	Task: No Safety Issue	#	Task: Safety Issue	#	Task: Unmeasured
6	Walk to aircraft	3	Weather check and flight plan	5	Restroom break
8	Contact OCC with flight plan	4	Pilot contacts medical crew to agree on flight acceptance	7	Sleep inertia
10	Remove rotor blade tie-down	11	Unplug aircraft from charger	9	Gather needed supplies
12	Remove air conditioner/heater/start cart	14	Pilot to complete preflight risk assessment	13	For low-light conditions, gather night vision googles
		15	Await confirmation from OCC regarding risk assessment	17	Pilot completes checklist
		16	Perform walk-around inspection of aircraft	18	Aircraft start-up
				20	REACH start-up/departure

OCC = operational control center.

that could be timed and had the potential to create a safety issue, and tasks that could not be reliably measured (Table 3).

Results

Overall, LOTs were relatively consistent across months and between the IF and SC groups, with an overall mean of around 11.85 minutes (standard deviation = 4.33 minutes), an IF mean of 12.63 minutes (standard deviation = 4.26 minutes), and an SC mean of 10.21 minutes (standard deviation = 4.02 minutes). Trends of overall means across calendar months can be seen in Figure 1 and by IF/SC group in Figure 2.

The difference between IF and SC mean LOTs was statistically significant, with a *P* value of .0000295 according to the linear model. Whether this is practically significant is debatable.

Although the Anderson-Darling test shows evidence of nonnormality ($P = .00001$), visually the data appear relatively normal with some right skew caused by unusually large values and left-truncated data (Fig. 3). The LOT was assumed normal with a mean of 11.85 minutes and a standard deviation of 4.33 minutes. Using these values, the expected percent of cases in which standard LOT cutoffs would be met are presented in Table 1 from 10 minutes through 20 minutes.

We next evaluated a range of times and the impact on the success rate for a defined LOT based on 2016 data. Ninety percent of all flights had an LOT between 4.73 and 18.97 minutes. Times were selected in 1-minute intervals between 10 and 20 minutes, and the percent success rates were tabulated (Table 1).

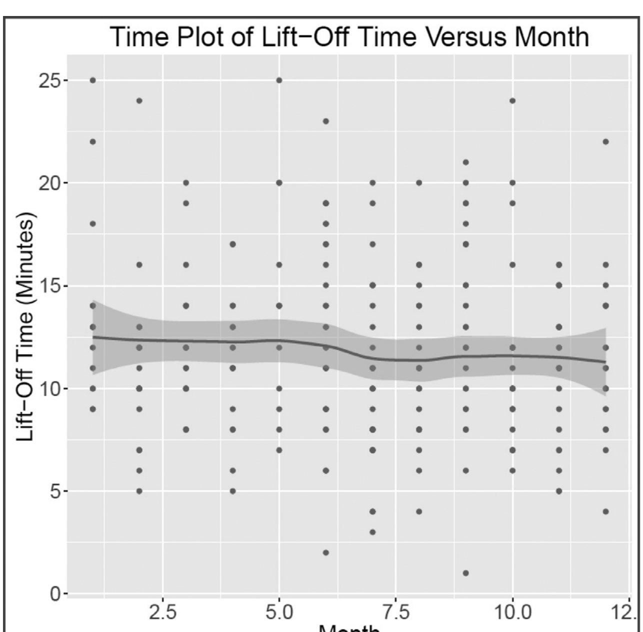

Figure 1. A Time Plot of LOT Versus Month.

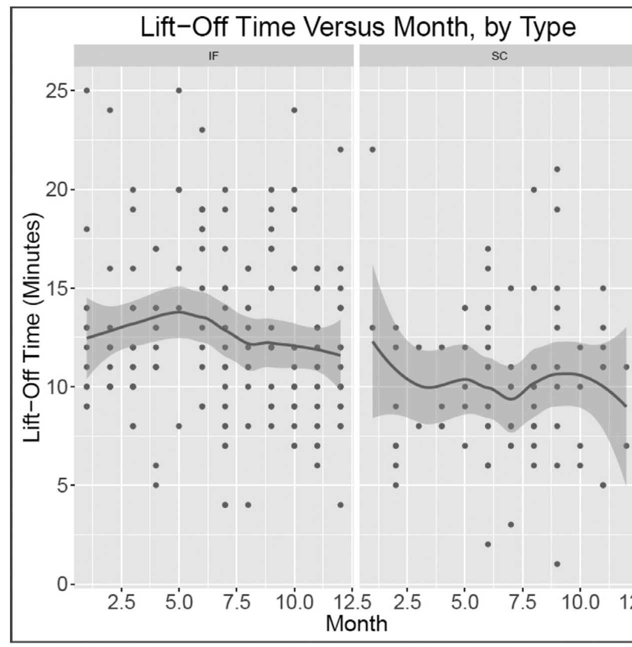

Figure 2. LOT Versus Month by Type.

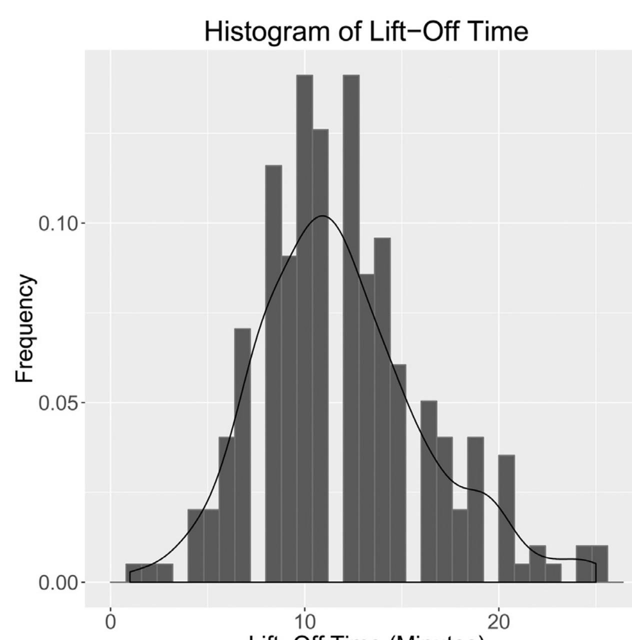

Figure 3. A Histogram of LOT.

Table 4

#	Task	Time
6	Walk to aircraft	4 minutes 8 seconds (average of 5 recorded times)
8	Contact OCC with flight plan	30 seconds
10	Remove rotor blade tie-down	1 minute 18 seconds
12	Remove air conditioner/ heater/start cart	1 minute 30 seconds

OCC = operational control center.

The 2016 LOT goal (75%) for SC calls (10 minutes) was met only 59% of the time. For IF transports (75%), the success rate was achieved 77% of the time with a combined rate of 73%. Our data suggest a mean LOT of 11.8 minutes, but the data presented earlier indicate that to achieve our goal of success greater than 75% would require 15 minutes. Based on this information, we assessed barriers to achieving a 11- to 13-minute LOT a greater percentage of the time. Figure 2 provides a graph of LOTs by month and type (IF/SC).

Table 2 is a list of tasks that must be completed before takeoff, beginning with the flight request. These tasks were then divided into 3 categories: 1) tasks that can be timed and did not pose a safety issue, 2) tasks that could be timed but did pose a safety issue, and 3) those that could not be reliably timed. Note that tasks 1 and 2 were not included in this list because LOT times begin once the pilot is notified of a potential flight (Table 3).

Once categorized, the tasks that could be timed and did not pose a safety issue were evaluated to see which might have the greatest impact on LOTs. These tasks were studied further to answer the following 3 questions: 1) Which activities or processes could be altered to improve LOT? 2) Were 2 separate LOTs required for IF transfers versus SC calls? and 3) Could we create a safe standard(s) for LOTs for our service?

Four tasks were identified that could be altered to affect process improvement: walk to aircraft, contact operational control center with flight plan, removal of rotor blade tie-downs, and removal of air conditioner/heater/start cart. These 4 items were timed (Table 4). In addition to timing tasks, gathering supplies was noted to be a variable for a delay in relation to LOTs. At the beginning of the study, multiple pieces of equipment were being stored at the crew offices. Because our medical crew assists with patient care in the hospital when not performing a transport, when a call is received, the crewmember must return to the office to retrieve specialized equipment and then return to the helicopter, further delaying departure. Several pieces of equipment were relocated to be stored at the helicopter, and the process to obtain blood products and medications from the pharmacy was streamlined. No timing was done in relation to this.

It was determined that contact with the operational control center could be completed while walking to the aircraft. Rotor blade tie-downs are only intermittently used during inclement/gusty weather but could not be eliminated. The helicopter is stored outside; therefore, climate control is required to maintain appropriate cabin temperatures for equipment and medications. We use a large unit that is connected to the aircraft via tubing placed in the windows. The walk from the crew quarters imposed a significant, unnecessary delay.

Discussion

LOTs are an essential tracking metric for flight services. Accrediting bodies such as CAMTS, Air Medical Physician Association, Association of Air Medical Services, and National Emergency Medical Services Pilots Association currently do not provide any standard guidelines for LOTs but do recommend that LOTs should be determined locally. Air medical transport has known hazards, and anything that places unnecessary pressure on pilots and crews should be recognized and eliminated. Conversely, most patients who are transported by helicopter have time-critical conditions, so standards must be maintained to ensure timely transport. Having internal standards to allow tracking and trending of air medical service response is key in promoting timely transport and identifying areas for improvement.

Because no data are available for current LOT goals, our service believed it was essential to have times that accurately reflected the reality of our service and to allow for event tracking. Our currently listed LOTs were divided for scene and interfacility transports, but our data confirm they could be combined. The data are consistent with a previous helicopter dispatch time study by Stanhope et al[8] stating that response times for scene flights were not significantly different than for interhospital transfers.

We further discovered that some of our specialty equipment was located at crew quarters rather than at the helipad (eg, fetal heart monitor and intra-aortic balloon pump), and this was another area for improvement. These supplies were originally kept at this location to facilitate training but have since been moved to the helipad to aid in decreasing LOTs without compromising safety. Finally, crew offices/quarters are remote from the helipad, which is located above the emergency department. We have been working closely with administration to change this location. This will decrease times by more than half and also allow crewmembers to be available to the emergency department as needed.

We also determined that weather checks should not be included in the LOT. This function is performed by the pilot and should be thorough and not hurried. Including it within the LOT metric creates pressure on the pilot and potentially compromises safety. We recommend starting the LOT timer at the time the pilot accepts the flight. This will shorten the overall measured LOT as well as eliminate a time-pressured weather check to be completed.

Limitations

During the study period (May), operational control of the aircraft changed from EagleMed (Wichita, KS) to REACH, LLC (Santa Rosa, CA). With the change in operational/departure procedures, a brief spike in LOTs was noted during the months of May and June, with the mean LOTs being 14.08 and 12.93, respectively. This might have accounted for the mildly increased overall LOT for 2016 statistics. In addition, the LOT was not further assessed to identify LOTs in relation to day or night shift (our crews work 12-hour shifts 7 AM-7 PM and 7 PM-7 AM) nor did the study identify LOTs for specific crewmembers. The 1997 study by Stanhope et al[8] found that the time of day did not significantly impact response times, supporting our decision to not track these times separately. In further discussion with team members and management, it was decided to not follow individual's or specific team's LOTs because this could potentially create a competitive culture that may compromise safety. Rather than identify the fastest or slowest LOT associated with individual team members, we opted to study the program as a whole in an effort to encourage teamwork and potentially limit negative impact focused on individuals.

Conclusions

Insufficient evidence exists from national air medical professional organizations and our data to support separate LOT goals for IF and SC calls. If an additional 9 of 248 met the LOT goals, the program would have met their goal metric of 75%. The mean LOT was 11.85 minutes for all flights. Based on these data, we have changed our quality management policy to 13 minutes as LOT goals for all flights. Discussions regarding the location of crew quarters is ongoing. Further research is needed to clarify factors influencing LOTs for programs that are specific and meet the needs of programs while not compromising safety.

Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amj.2018.12.001.

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