The Wellington Life Flight Helicopter Emergency Medical Service (HEMS): a retrospective audit against new Ministry of Health criteria

Katherine Gordon, Andrew Swain, Callum Thirkell, Mark Bailey, Dave Greenberg

Abstract

Aim To analyse the clinical and operational indications for activating the Wellington Life Flight helicopter emergency medical service (HEMS) against draft Ministry of Health (MOH) criteria.

Method Wellington HEMS records for 3 years were reviewed. Details of mission location, timings, medical procedures, patient demographics, and primary reasons for dispatch were analysed.

Results 471 missions were reviewed. The main reasons for helicopter dispatch were anticipated time savings (47%), geographical access (36%), provision of skills (7%), or a combination (10%). In 62% of total missions, a road ambulance and helicopter were both dispatched. The helicopter was dispatched after the road ambulance had arrived at the scene in 52% of these cases, with a median lag time of 11 minutes and 12 seconds, and median waiting on scene time of 27 minutes 28 seconds. The road ambulance arrived first in 77% of cases. The median arrival time by air was 26 minutes compared to 11 minutes 45 seconds by road. In contrast, the transfer to hospital by helicopter was quicker in 99% of cases, with a median flight time of 15 minutes compared to 49 minutes by road.

Conclusion Wellington HEMS offers advantage over the road ambulance when dispatched and utilised appropriately. The majority of missions satisfied the MOH activation criteria but time-saving issues became apparent. Changes to the Helicopter Dispatch Flowchart have been proposed as a result. Further studies are required to assess any improvement in HEMS response times as the service develops. This data provides a benchmark for audits of future operational and clinical performance.

The Wellington Life Flight helicopter emergency medical service (HEMS) is an important healthcare service provided to the Greater Wellington Region (including the Wairarapa).

When a patient is critically ill or injured, and/or in a remote location, the emergency helicopter can be dispatched to deliver aid. Helicopters offer advantage over road ambulance as they travel at higher speed (190–290 kph), follow more direct routes, and avoid traffic and other road conditions that can slow land transport. Additionally, advanced paramedic care can be delivered as the intensive care flight paramedics (ICPs) are trained to carry out advanced airway management, rapid sequence intubation (RSI), chest decompression, as well as the administration of additional medications.
Appropriate use of HEMS is vital to maximize the patient benefit from this limited and expensive resource. Saving time transporting the patient to hospital, or bringing more advanced medical skills than that provided by ground services, has been found to maximise patient benefit in trauma situations. Additionally, it is important that the dispatch system clearly differentiates the more severely sick or injured from the less severely sick or injured, so that the service is primarily activated for patients with critical conditions. It is clear that well-defined criteria are required to appropriately and effectively dispatch the Wellington HEMS to an incident.

The Clinical Advisory Group (CAG) constituted by the National Ambulance Sector Office (NASO) of the Ministry of Health (NZ) have summarised these criteria by means of the acronym ANTS, standing for Access, Number, Time and Skill.

The aim of this study was to retrospectively analyse the clinical and operational activation of the Life Flight HEMS and audit this against the draft Helicopter Dispatch Protocols produced by NASO.

The response times of the helicopter compared to road ambulance, as well as the spectrum of work and the application of advanced clinical skills, were analysed for the first 3 years of the service. This information is critical for assessing the impact and efficiency of this potentially life-saving service and the benefits to the patient and the emergency services. The results will also provide a benchmark for further analyses and comparison against similar services.

**Method**

**Study design**—All missions undertaken by the Wellington HEMS during the 3-year period from 28 October 2010 to 27 October 2013 inclusive were reviewed retrospectively. Data from helicopter flights were entered into an Excel spreadsheet (Microsoft Corporation, Redmond, WA) by the duty ICP. Data recorded included the date, name of treating ICP, incident number, location, ambulance status of the patient at the scene and on arrival at the destination, ICP-level clinical interventions, case description and outcome.

Basic demographics for each patient (age and gender) were recorded. The following times were documented: 111 phone call received by the ambulance communication centre, helicopter activation, lift-off, arrival on scene, departure from the scene and arrival at the destination hospital. The cause of any delay was also documented.

The times from lift-off to arrival at the scene were taken from TracPlus software (TracPlus Global Ltd, Dunedin, NZ) which monitors and tracks the helicopter in real time. Other times (e.g. call received, activation time) were taken from Opus (3tc Software, Desford, UK) which logs them to the nearest second. From these absolute times, differences were calculated to establish intervals such as activation-to-liftoff, activation-to-arrival time, scene time, patient transport time etc.

Inclusion criteria were emergency flights in which a patient was transported and/or treated. Exclusion criteria were flights which were cancelled, or instances in which the patient was not transported or treated (e.g. police search missions).

One author (CT) who is both an ICP and a Communications Centre clinician experienced in helicopter dispatch, also analysed data from computerised Incident Detail Reports (VisiNet, Tritech Software Systems, San Diego, CA) to determine for each mission whether the helicopter was dispatched for reasons of access, number of patients, time factors, or skill requirements (ANTS criteria), or a combination of these, as detailed in Table 1 below.
Table 1. ANTS criteria

| A – access: | Where road access is difficult to the extent that a helicopter is the only feasible means of access to the patient (e.g. remote areas, areas without roads). |
|N – number: | Where the estimated number and condition of patients is such that sufficient personnel cannot reach the scene in a reasonable time by road. |
|T – time: | Where the patient has what is considered to be a “time-dependent” problem and use of a helicopter will significantly shorten: The time for clinical personnel to first reach the scene, OR The time for the patient to be transported to an appropriate hospital Time-saving targets are: Status 1 (time-critical) patient: the helicopter will transport more than 15 minutes faster than a road ambulance Status 2 (time-urgent) patient: the helicopter will transport more than 30 minutes faster than a road ambulance Status 3/4 (time-sensitive) patient: the helicopter will transport more than 2 hours faster than a road ambulance. |
|S – skill: | Where the patient appears to have a ‘skill-dependent’ problem (e.g. requires rapid sequence intubation (RSI), or specialised medications such as ketamine) and use of a helicopter with an appropriate paramedic will: Significantly shorten the time for that skill to be delivered to the patient in accordance with the status code (see above) OR b) Decrease the clinical risk to the patient during transport. |

Response times—The response times to the incident for helicopter and road ambulance were calculated and compared. Helicopter response times were taken from the database generated by the ICPs using TracPlus, whereas road ambulance data was obtained from VisiNet. In order to be comparable to the helicopter, response times for the closest ambulance capable of treating and transporting the patient were recorded. “Time saved” for transporting Status 1, 2, and 3 patients to hospital were compared against the NASO draft Helicopter Dispatch targets.

Retrieval times—In all cases analysed it was the helicopter that delivered the patient to the medical destination. The equivalent road transport times, if no helicopter had been available, were calculated from the exact patient address to the destination hospital using Google Maps (Google Inc, Mountain View, CA) to provide an estimated road transport time.

Definitions for the time intervals calculated are:
- **Time-to-liftoff** = interval between helicopter activation and being airborne.
- **Lag time** = time between road ambulance dispatch and helicopter dispatch.
- **Waiting time** = delay between road ambulance arrival and subsequent helicopter arrival at the scene.

Night missions were also compared with day missions.

The study was approved by the University of Otago Ethics Committee (H13/046).

**Results**

Of 623 missions over the 3-year period, 471 matched the inclusion criteria. Of these, there were 126 in 2010-2011, 173 in 2011-2012, and 172 in 2012-2013.

**Demographics (Table 2)**—157 females and 314 (66.7%) males were rescued by the helicopter over the 3 year period. The peak age group was 55–64 years for females (20% of females) and 45–55 years for males (17% of males). The most common locations for rescue were Kapiti Coast (38%), South Wairarapa (12%), Wellington area (9%), and Masterton/North Wairarapa (9%). The most common clinical reasons
for rescue were trauma (54%), cardiac illness (13%), general medical conditions (8%), and collapse (6%).

Table 2. Demographics of patients

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age range</th>
<th>Location</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>&lt;6 months</td>
<td>Carterton</td>
<td>2.5%</td>
</tr>
<tr>
<td></td>
<td>6–12 months</td>
<td>Horowhenua</td>
<td>0.6%</td>
</tr>
<tr>
<td>Male</td>
<td>1–9yrs</td>
<td>Kaikoura</td>
<td>0.8%</td>
</tr>
<tr>
<td></td>
<td>10–14yrs</td>
<td>Kapiti Coast</td>
<td>38%</td>
</tr>
<tr>
<td></td>
<td>15–24yrs</td>
<td>Lower Hutt</td>
<td>5.1%</td>
</tr>
<tr>
<td></td>
<td>25–34yrs</td>
<td>Manawatu</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td>35–44yrs</td>
<td>Marlborough</td>
<td>7.9%</td>
</tr>
<tr>
<td></td>
<td>45–54yrs</td>
<td>Masterton</td>
<td>8.9%</td>
</tr>
<tr>
<td></td>
<td>55–64yrs</td>
<td>Nelson</td>
<td>0.8%</td>
</tr>
<tr>
<td></td>
<td>65–74yrs</td>
<td>Offshore</td>
<td>0.8%</td>
</tr>
<tr>
<td></td>
<td>75–84yrs</td>
<td>Other</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td>85–94yrs</td>
<td>Palmerston North</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Porirua</td>
<td>3.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South Wairarapa</td>
<td>11.9%</td>
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<tr>
<td></td>
<td></td>
<td>Tararu</td>
<td>1.7%</td>
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<tr>
<td></td>
<td></td>
<td>Upper Hutt</td>
<td>7.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wellington</td>
<td>8.9%</td>
</tr>
</tbody>
</table>

Patient care—Of the 471 flights analysed, the patient’s condition on arrival was deceased (Status 0) in 1%, immediately life-threatening (Status 1) in 14%, potentially life-threatening (Status 2) in 38%, unlikely to be life-threatening (Status 3) in 31%, or of no threat to life (Status 4) in 14%. ICP procedures were used in 222 out of 471 missions, with 32 of these being RSI.

Advanced analgesia (ketamine or intravenous morphine with or without midazolam) was used in 133 missions (28%). Other ICP interventions were used in 29 missions and these included cardiac arrhythmia treatment, asthma medication, intravenous ceftriaxone, chest decompression, post-intubation sedation and/or paralysis, pulmonary oedema treatment, and thrombolysis.

Of the 69 Status 1 patients, 41% required RSI, 11% required ICP analgesia, 14% required other ICP interventions, 19% required multiple interventions, and 14% required no intervention.

Application of ANTS criteria (Figure 1)—Across the 3 years, the main indications for helicopter dispatch (Figure 1) were time (47%), access (36%), skills (7%), or a combination of these (10%). There were 18 occasions (4%) when the helicopter was dispatched because of a temporary lack of appropriately situated ambulance resources. On 18 separate occasions (4%), the reason for dispatching the helicopter was deemed “inappropriate”.
Figure 1. Primary reasons for helicopter dispatch

Night missions—Analysed separately from the 471 day missions, 32 missions were undertaken at night. ICP interventions in this group included RSI (2), ICP analgesia (5), and multiple interventions (1). The most common locations for night missions were Kapiti (28%), South Wairarapa (22%), Marlborough (13%) and Masterton (13%), with none in the Wellington area. The patients were therefore located in more distant or remote areas.

Time intervals—The median time-to-liftoff interval for day missions was 8 minutes (IQR 5m to 11m9s), compared to 18 minutes and 32 seconds (IQR 12m36s to 26m46s) for night missions. Median times from activation to arrival at the scene, as well as median time to destination from the scene were calculated, for both air and road transport (Figure 2).

From activation to arrival at scene, the median time was 26 minutes (IQR 20m50s to 36m28s) by helicopter and 11 minutes and 44 seconds (IQR 6m59s to 23m52s) by road. Therefore land transport, on average, reached the patient more quickly. In contrast, the median time from the scene to destination by helicopter was 15 minutes (IQR 11m24s to 19m53s), whereas median road time was 49 minutes (IQR 42m to 55m30s). Therefore air transport, on average, transferred the patient to the regional hospital more rapidly.
The helicopter spent a median time at the scene of 28 minutes (IQR 15m34s to 40m). In 292 of 471 (62%) helicopter missions, a road ambulance was also dispatched to the scene. When both helicopter and road ambulance were dispatched, in 154 out of 292 cases (53%) the helicopter was only dispatched after the road ambulance had arrived at the scene. In these cases, the median activation “lag time” was 11 minutes and 14 seconds (IQR 5m25s to 19m14s).

The median “waiting time” on scene for the helicopter was 27 minutes and 37 seconds (IQR 15m46s to 38m36s). Of the 292 cases when both helicopter and road ambulance were dispatched to the scene, 277 cases (95%) had complete outward and return time data for both air and road transport. From this data, the time saved in the return trip for each flight was calculated. In 259 of these 277 cases (94%) the helicopter saved time on the return trip.

When looking at missions where the primary reason for activation was “time”, missions were categorised as to whether the patient was Status 1, 2 or 3/4 on paramedic arrival. To satisfy the targets listed in the NASO draft Helicopter Dispatch Protocol, the time saved in either direction by using the helicopter (i.e. either to reach the patient or to transfer the patient to hospital) must be 15 minutes for Status 1 patients; 30 minutes for Status 2 patients; and 2 hours for Status 3/4 patients.

When analysed, the median time saved by the helicopter was 35 minutes and 45 seconds for Status 1 patients, with 95% of incidents saving at least 15 minutes. The median time saved for Status 2 patients was 35 minutes, with 78% of incidents saving at least 30 minutes. The median time saved for Status 3/4 patients was 37 minutes and 15 seconds, with only 6% of patients benefiting from a time saving of at least 2 hours. However 8 of these patients (10%) had a secondary reason for helicopter activation, which provided justification for those trips.
The draft Helicopter Dispatch Protocol Flowchart (Appendix 1) was also considered. Author CT, who analysed the data in relation to the ANTS criteria, proposed ways in which the flowchart could be improved. The recommendations for both day & night dispatches, and the changes incorporated, are included in Appendix 2.

It should also be mentioned that the helicopter is occasionally used for interhospital transfers (18% of all transfers) and during this time, it is unavailable for emergency services. The helicopter was used for 177 medical transfers during our study period.

Discussion

The rational and appropriate use of Wellington HEMS is vital to ensure maximum benefit to patients while minimising potential costs and safety concerns. We can find no other published analysis of missions carried out by HEMS in New Zealand and this is the first to characterise reasons for helicopter dispatch in the Greater Wellington Region.

Sixty-six percent of Wellington HEMS patients were male, mainly in the age range of 45–55 years, and the common clinical indications were trauma (54%) and cardiac causes (13%). Most were retrieved from the Kapiti Coast (37%) or South Wairarapa (12%) which is consistent with our findings that “time” (47%) and “access” (36%) were the main reasons for helicopter dispatch.

Most patients were classified on arrival at the scene as Status 2 (38%) or Status 3 (31%), which was unexpected considering that the helicopter service is primarily intended for critically ill or injured patients. However, the “time” factor includes occasional situations in which a temporary lack of appropriately situated ambulance resources warranted use of the helicopter for patients with lower acuity conditions (18 instances in this study).

Interestingly, our expert found that 18 flights were dispatched for “inappropriate” reasons. We expect that with a clearer dispatch protocol, inappropriate activation should be reduced in the future.

Wellington HEMS is most often activated to reduce the time taken to transfer the patient to hospital and allow better access to the location. However, time saved is only beneficial if it includes both the outward and return helicopter journeys, especially as road ambulances usually respond from locations much closer to the patient.

In 53% of cases when both helicopter and road ambulances were used, the helicopter was dispatched 11 minutes after the ambulance had reached the scene. In these instances, it seems that the helicopter was dispatched more as an after-thought, rather than as a primary clinical resource. Furthermore, the median time the road ambulance spent waiting for the helicopter to arrive was 27 minutes. This has a significant impact on the total time taken by the helicopter to transfer the patient to the treating hospital. Despite these delays, use of the helicopter failed to save time in only 6% of cases.

When the primary reason for helicopter activation was “time”, the majority of Status 1 and 2 patients met the NASO targets for time-saving (15 and 30 minutes respectively). However, 94% of missions involving Status 3 patients failed to save 2 hours.
The helicopter dispatch lag time and lack of time-savings for Status 3 patients highlight the need for clearer helicopter activation criteria for communication centre personnel responding to 111 calls. To try and achieve this, we have proposed changes to the draft Helicopter Dispatch Flowchart (Appendix 2).

Although only 32 night missions were completed during the study period, the availability of HEMS at night is still an essential service, particularly to more distant or remote areas. However, it does takes longer to respond at night when the crew are located off base. This is evident from the median time-to-liftoff of 18 minutes at night compared to 8 minutes during the day.

On average, road ambulances reached the patient 14 minutes faster than the helicopter, and were first to reach the scene 77% of the time. This finding is consistent with those reported in another study. However, the Wellington Life Flight helicopter transferred the patient to hospital 34 minutes quicker, and achieved this faster than a road ambulance 99% of the time. This finding is consistent with that reported by Svenson et al and it illustrates the need in critical cases for road and helicopter resources to be dispatched simultaneously to enable the fastest clinical response to the scene and the most rapid transfer to hospital.

By road and air transport working together, maximum patient benefit may be achieved. Although the helicopter spent 28 minutes at the scene with the patient, this could be reduced if the patient is stabilised and prepared for any ICP procedures and transport when the helicopter arrives. Scene times can be reduced by good coordination between helicopter and road ambulance personnel.

Advanced clinical procedures such as RSI, specialised analgesia or medication, and chest decompression are vital skills provided by the ICPs on HEMS, and these were used in 47% of missions analysed in this study. These skills are expected to have a significantly beneficial effect on patient outcomes, particularly for Status 1 patients requiring RSI. Although RSI training has increased over the three-year period, we did not see a corresponding increase in the number of RSI cases. This suggests that the ICPs only use these skills when the situation demands it.

As a resulted of this study, some changes to the original helicopter dispatch flow chart have been proposed (see appendices 1 and 2). The specific skill set of the flight paramedic, in addition to the ICP skills possessed by this group, should be considered by the dispatcher. There are also situations in which local hospitals should be bypassed to enable a patient needing treatment in a regional or supraregional unit to be flown there directly. Finally, at night the dispatcher should take advice from the duty team manager if the senior paramedic advisor on the Clinical Desk (CD) is unavailable.

Limitations of this study include firstly its retrospective nature and reliance on administrative data. However, all timings and clinical details were cross-checked for accuracy against other databases.

Secondly, although data was missing or inadequate in some fields, this amounted to less than 5% in any category. With a sample size of 472, we did not consider this to be a major limiting factor.
Thirdly, although Google Maps were used to estimate the road transport time from the patient’s location to the destination hospital, the time used was that quoted for traffic-free conditions. Bearing in mind that ambulances achieve their advantage mainly by cutting through traffic congestion, and that they are limited to only 30 kph above the speed limit for any section of road, it is believed that the calculations for time to hospital are accurate and do not favour the helicopter to any significant extent.

Fourthly, the classification of flights into the different ANTS criteria was not undertaken by an independent expert but relied on the expertise of a senior and experienced paramedic who was still employed by Wellington Free Ambulance at the end of the study.

Fifthly, the study did not explore patient outcomes in any depth. Therefore the results of this study cannot determine the efficacy of the service in terms of patient benefit nor cost-benefit. However, the data does highlight the need for clear helicopter activation criteria for communications personnel.

This study has significant implications for the future activation of Wellington HEMS. It has been proposed that NZ adopts an ‘air desk’ system, which allocates the role of helicopter dispatch to a specific control centre operated by flight-trained ICPs with more specialised knowledge. Similar systems are used in Nova Scotia4 and the UK11.

**Conclusion**

The Wellington Life Flight helicopter is an essential life-saving service, and offers advantages over road ambulance when dispatched and utilised appropriately. When compared against the MOH draft dispatch protocol, the majority of missions meet the NASO time-saving criteria for Status 1 and 2 patients, but not for Status 3/4 patients.

This highlights the need for clear helicopter activation criteria for communication centre personnel responding to 111 calls. Potential changes to the draft national Helicopter Dispatch Flowchart have been proposed to try and achieve this. Further studies are required to assess whether there is any improvement in response times and times on scene as the HEMS service develops beyond its first 3 years. However, the data in this paper will serve as a benchmark for audits of future operational and clinical performance.

**Competing interests:** Nil.

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References:
APPENDIX 1:

Flow Chart: Immediate (Dispatcher-initiated) Helicopter Dispatch (CD=Clinical Desk)

Call handling – Initial information suggests helicopter should be considered

Access: Is access impossible or impractical by road?

Yes

Consider: Is winching required? Which aircraft/service is most suitable?

Dispatch Helicopter

No

Number: Does the number of patients exceed the resource that can readily be provided by road in reasonable time?

Yes

Discuss with CD Paramedic: May require discussion with Team Manager: May meet MCI criteria.

Dispatch most appropriate resources

No

Time: Does this sound likely to be a time-critical problem?

Yes

Is the incident in a location where helicopter response and transport is known to be significantly faster than road (at least 15min time saving)?

Yes

Dispatch Helicopter

No

Await more information: Ongoing discussion with CD Paramedic

No

Dispatch Road Crew

Uncertain

Await more information: Ongoing discussion with CD Paramedic

_skills: Does the patient have a skill-dependent problem likely to exceed the capabilities of readily available road crew(s)? (Discuss with CD Paramedic)

Yes

Consider: What skills/capabilities are required? Which aircraft/service is most suitable?

Dispatch Helicopter

No

Dispatch Road Crew

Uncertain

Await more information: Ongoing discussion with CD Paramedic
APPENDIX 2:

Proposed changes to original flowchart – for day missions (see shaded boxes)

Call handling - Initial information suggests helicopter should be considered

- **Access**: Is access impossible or impractical by road?
  - Yes: Consider: Is winching required? Which aircraft/service is most suitable?
  - No
    - **Number**: Does the number of patients exceed the resource that can readily be provided by road in reasonable time?
      - Yes: Discuss with CD Paramedic: May require discussion with Team Manager: May meet MCI criteria.
      - No
        - **Time**: Does this sound likely to be a time-critical/Urgent/Sensitive problem?
          - Yes: Is the incident in a location where helicopter response and transport is known to be significantly faster than road (at least 15min time saving)?
            - Yes: Dispatch Helicopter
            - No: Dispatch Road Crew
          - No: Uncertain
            - **Skills**: Does the patient have a skill-dependent problem which may benefit from additional flight skills such as RSI, or other ICP skills? (Discuss with CD Paramedic) Is a specialist hospital likely e.g. burns, TBI, cath lab, multi-trauma, spinal unit?
              - Yes: Consider: What skills/capabilities are required? Which aircraft/service is most suitable?
              - No: Dispatch Road Crew
              - Uncertain: Ongoing discussion with CD Paramedic.
            - **Await more information: Ongoing discussion with CD Paramedic.**
APPENDIX 2 (contd.):

Proposed changes to original flowchart – for night missions (see shaded boxes)

1. **Call handling – initial information suggests helicopter should be considered**
   - **Access:** Is access impossible or impractical by road?
     - **Yes:** Consult Team Manager → Dispatch Helicopter
     - **No:**
       - **Number:** Does the number of patients exceed the resource that can readily be provided by road in reasonable time?
         - **Yes:** Consult Team Manager → Dispatch most appropriate resources
         - **No:**
           - **Time:** Does this sound likely to be a time-critical problem?
             - **Yes:** Will at least 15min be saved by sending the helicopter?
               - **Yes:** Dispatch Helicopter
               - **No:** Dispatch Road Crew
             - **No:** Uncertain
               - **Skills:** Does the patient have a skill-dependent problem which may benefit from additional flight skills such as RSI, or other ICP skills? *(Discuss with CD Paramedic)* Is a specialist hospital likely e.g. burns, TBI, caudal, multi-trauma, spinal unit?
                 - **Yes:** Dispatch Helicopter
                 - **No:** Dispatch Road Crew
               - Uncertain
                 - **Await more information: Consult Team Manager**
               - **Await more information: Consult Team Manager**

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