Use of a Novel Application to Optimize Aircraft Utilization for Non-Urgent Patient Transfers.

Russell D. MacDonald MD MPH1,2, Mahvareh Aghhari MEng1, Tim A Carnes PhD3, Shane G. Henderson PhD3, David B. Shmoys PhD3

1Ornge Transport Medicine, Toronto, Ontario Canada
2Division of Emergency Medicine, Department of Medicine, University of Toronto, Toronto, Ontario, Canada
3School of Operations Research and Information Engineering, Cornell University, Ithaca, NY, USA

Background
Aircraft are used for interfacility patient transfers to provide timely transfer to referral centers. Some transfers are non-emergent and can be scheduled and routed for efficient aircraft use. Commercial airlines have comprehensive programs and infrastructure to ensure optimized flight schedules and aircraft utilization. Air medical services operate on a smaller scale, do not operate on a fixed schedule, and cannot predict demand or utilization due to the nature of their service. However, air ambulance services have the same need to optimize utilization to minimize cost while meeting demand. Optimized deployment of air medical resources enhance access while decreasing cost.

Objectives
This study compared use of a novel optimization application and algorithm derived from historical call, aviation, and financial data with traditional manual methods to plan non-emergent patient transfers using fixed wing aircraft. The study hypothesis is that an optimization application will decrease aircraft utilization while meeting all scheduled patient transfer requirements.

Methods
Retrospectively examine all fixed wing flight schedules and routes planned by the OCC for non-urgent fixed wing transfers from fifty (50) randomly sampled dates between July 2010 and February 2011. Steps: 1) Retrieve schedule and route planning information from dispatch data. 2) Use application to derive optimized flight schedules and routes. 3) Calculate total flying time and distance for each proposed schedules and routes; determine flights where a patient was on board the aircraft. 4) Calculate cost for each flight based on data from financial records. 5) Use expert opinion to determine validity of proposed flight schedules and route plans.

Data analysis
Time, distance, and costs – continuous variables, descriptive statistics. Differences in times, distances, proportions of empty legs, and cost - mean; compared using unpaired t-test, with p<0.05 considered significant.

Outcome Measures
Primary: differences in time and distance flown, comparing manually derived flight schedules and those derived by the application. Secondary: differences in proportion of empty legs flown and cost flights each day; proportion of valid plans proposed by the application.

Results
838 requests for non-urgent transfers during study period – daily mean 16.8 ± 5.4. All requests met by schedules and plans made by dispatch centre staff.

<table>
<thead>
<tr>
<th></th>
<th>dispatch center staff</th>
<th>optimized solution</th>
<th>difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td>flights</td>
<td>312</td>
<td>305</td>
<td>7</td>
</tr>
<tr>
<td>hours</td>
<td>1417</td>
<td>1253</td>
<td>164</td>
</tr>
<tr>
<td>distance (km)</td>
<td>481,381</td>
<td>417,156</td>
<td>64,225</td>
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<tr>
<td>% empty</td>
<td>35.5</td>
<td>32.8</td>
<td>2.7</td>
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*all differences significant to p < 0.05

Optimization application resulted in significant net savings in all measured outcomes.

All flight plans proposed by optimization algorithm deemed valid by expert opinion. The optimization algorithm is projected to yield a 16.5% decrease in cost.

Limitations
Actual distance flown by aircraft may differ from true distance between original and destination due to weather, flight path, and other aviation factors. Times depend on direction of flight (east-west versus west-east) and prevailing winds; however, optimization algorithm and financial data distinguished between flight direction in time and cost calculations. Fuel costs are driver in cost, and fuel cost fluctuates. Cost calculations in this study not influenced by fuel fluctuations due to contracted prices. This may not be applicable in other settings. Application only considered fixed-wing operations. Results may not be applicable to rotor-wing operations.

Conclusions
Use of prospectively derived novel optimization application can satisfy all requests for transfer while decreasing aircraft utilization and cost of non-urgent patient transfers on fixed wing aircraft. Further work is needed to determine whether prospective, real-time use of the optimization application will realize these savings.