

A Novel Application to Optimize Utilization for Nonurgent Air Transfers

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Abstract

Objective: Air ambulances provide patients with timely access to referral centers. Nonemergent transfers are planned for efficient aircraft use. This study compares a novel flight planning optimization application to traditional planning methods.

Methods: This prospective study compared real-world use of the application to traditional methods in a large air medical system. Each day was randomized to application use or manual methods. Descriptive statistics compared the resulting schedules through ratios of distance flown and cost to minimum distance required.

Results: Manual methods were used on 33 days to plan 479 requests, yielding 181 flights, 856 flying hours, and 289,627 km flown. Ratios of distance flown and cost were 1.47 km flown and \$4.98 per km required. The application was used on 25 days to plan 360 requests, yielding 146 flights, 639 flying hours, and 216,944 km flown. The corresponding ratios were 1.4 km flown and \$4.65 per km required. The average distance flown per distance required decreased by 5% ($P = .07$), and the average cost per average required distance decreased by 7% ($P = .03$) when using the application.

Conclusion: Prospective, real-world use of the application results in efficiencies when planning nonurgent patient transfers. Additional savings may be possible through further application refinements.

Introduction

Aircraft dedicated for air ambulance use perform interfacility patient transfers and provide timely access to referral centers for those requiring this type of specialist care. Although some of these transfers are emergent and time dependent, others are nonemergent and can be scheduled and routed to ensure efficient use of aircraft.

The commercial airline industry has comprehensive programs and infrastructure to ensure flight schedules and aircraft use are optimized to ensure maximum passenger traffic and revenue. Air ambulance services operate on a much smaller scale, do not operate on a fixed schedule, and cannot predict demand or use because of the nature of their service. However, air ambulance services have the same need to optimize use to minimize cost while meeting the demands of the health care system. Efficient deployment of air medical resources can enhance access to these services while potentially decreasing cost because of optimized resource use.

This study examines the implementation of a novel optimization application derived from historical call, aviation, and financial data for scheduled patient transfers in a provincial air ambulance system. The application was developed in partnership between an air medical and critical care land transport agency and an internationally recognized leader in developing systems to optimize resource allocation and scheduling in emergency services and the airline industry.

The goal of this study was to assess the impact of an optimization application on aircraft use in a provincial air ambulance system. The study hypothesis is that an optimization application will result in decreased aircraft use with resultant decreases in cost while meeting all scheduled patient transfer requirements.

Methods

Study Design

This study was performed in 2 phases. The first phase was a retrospective, offline comparison of scheduled patient transfers with traditional manual planning methods performed by experienced flight planners as part of their regular duties. The second phase was the prospective, real-time assessment of the application's impact on use after live deployment in the dispatch center. The study was approved by the Research Ethics Board at Sunnybrook Health Sciences Centre.

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Study Setting and Population

Ontario is a large Canadian province (approximately 1.1 million km² or 424,600 miles²) with a mix of urban, suburban, rural, and remote areas. The health care system is publicly funded and serves a population of approximately 13.5 million. Ornge Transport Medicine is the publicly funded air medical transport system providing all air medical patient transfers in Ontario. Ornge is Canada's largest air medical and land critical care transport provider, performing approximately 19,000 patient transports annually. Ornge uses a fleet of 26 aircraft and 4 land vehicles to perform these transfers. The fleet remained the same during this study. Approximately half the transfers are for patients with nonemergent conditions that are scheduled.

The Ornge Communications Centre (OCC) is the provincial air ambulance dispatch center; it processes and dispatches all air ambulance and land critical care transfer requests in Ontario. It also coordinates all scheduled, non-emergent patient transfers that require use of an air ambulance or land critical care transfer vehicle. Dispatch staff use a dedicated dispatch software system to process and document all requests for transfer by air ambulance. The dispatch database contains all relevant flight and schedule information for this study.

The optimization application was developed as a partnership between Ornge and The Cornell College of Engineering's School of Operations Research and Information Engineering (ORIE). The application is a complex computer modeling application with optimization algorithms designed to provide solutions that meet all patient transfer demands while optimizing flight time and cost.¹ The model was built using Ornge's dispatch, aviation, and finance data, and the optimization application resulting from the model has been tested operationally.^{1,2} The application provides valid flight scheduling and planning solutions, but its actual impact on aircraft use has not been formally assessed.

Study Protocol

Phase 1

The first phase of this study retrospectively examines all flight schedules and routes planned by the OCC for nonurgent fixed-wing transfers from 50 randomly sampled dates between July 1, 2010, and February 28, 2011. Schedule and route planning information was retrieved from the dispatch database for each randomly selected day.

The investigators calculated the total flying time and distance flown for all schedules and routes each day based on actual reported flight times captured in the dispatch database as reported by the aircraft pilot in command. The investigators determined the flights when a patient was on board and when there was no patient on board based on dispatch information. The daily cost was determined using data from actual invoicing records and financial data for each flight.

The investigators also examined each route flown to determine differences in distance flown and flight time for each

actual flight reported by the pilot compared with each optimized flight derived from aggregate historic and operational data. The investigators then used the application to derive optimized flight schedules and routes for each of the 50 randomly selected dates. The data required by the application include patient origin, destination, required pickup time (if any), required drop-off time (if any), level of care, patient escort (if any), and whether the patient has any infectious disease precautions.

The total flying time and distance flown for each proposed schedule and route were calculated by the application based on aggregate historic flight and operational data. The flights when a patient was on board the aircraft were also determined. The cost for each flight was calculated based on data from financial records. The investigators used expert opinion from a senior, experienced flight planner to determine the validity of each flight schedule and route plan proposed by the application.

Phase 2

The second phase of this study was the prospective evaluation of the application in real-time use after the application was integrated into routine dispatch operations in the OCC. Flight planners involved in the planning of nonemergent patient transfers were first trained in application use before the study period. Training was delivered by education personnel and 1 investigator (MA) based on a training package developed by the educational personnel in cooperation with the investigators. The training package included a self-directed reading component done on the flight planner's own time followed by a 2- to 3-hour didactic training and a 3- to 4-hour hands-on training session with the application itself. The application was installed at the nonemergent flight planner's workstation on completion of the training period.

The investigators collected and examined all flight schedules and routes planned by the OCC for nonurgent fixed-wing transfers between June 8 and August 17, 2011. Flight planning was randomized to either optimization application use or manual methods based on predetermined randomization maintained by 1 investigator (LW). Schedule and route planning information proposed by the application was stored in the OCC dispatch system and retrieved at the beginning of each day shift. A single flight planner planned each day.

The total flying time and distance flown for each proposed schedule and route were calculated by the application based on aggregate historic flight and operational data. The flights when a patient was on board the aircraft were also determined. The cost for each flight was calculated from financial records.

The investigators also retrieved data from the previous day's schedule and routes to determine actual flying time and distance flown for each route and any differences in distance flown and flight time for each actual flight reported by the pilot compared with that derived from aggregate historic and operational data. The investigators used expert opinion from a senior, experienced flight planner to determine the validity

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