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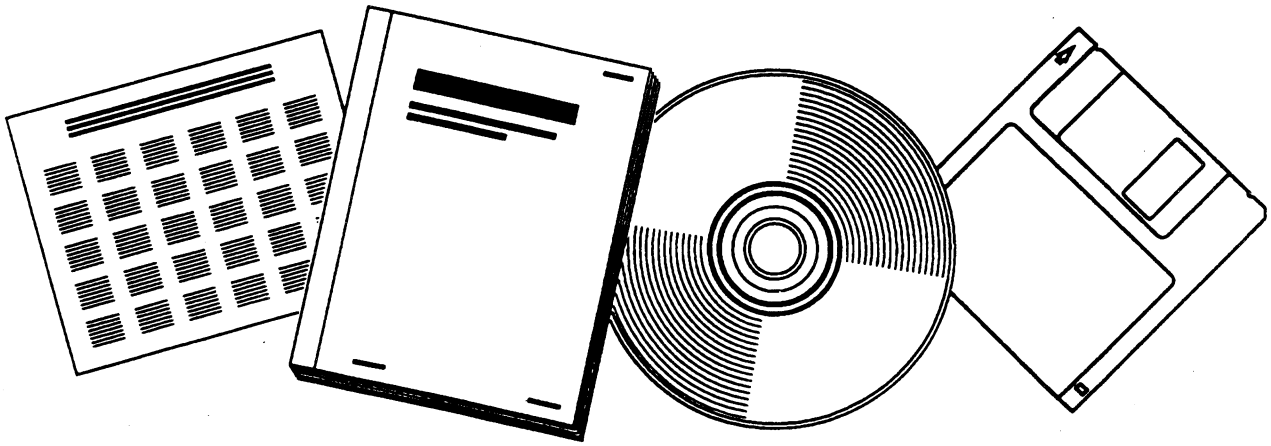

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

DOT/FAA/AM-97/2

Office of Aviation Medicine
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Inflight Medical Care: An Update

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19970320 011

February 1997

Final Report

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U.S. Department of Transportation

Federal Aviation Administration

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Technical Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-97/2		

4. Title and Subtitle	5. Report Date
Inflight Medical Care: An Update	February 1997
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Charles A. DeJohn, M.D.; Stephen J.H. Veronneau, M.D.; and Jerry R. Hordinsky, M.D.	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
FAA Civil Aeromedical Institute P.O. Box 25082 Oklahoma City, OK 73125	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Office of Aviation Medicine Federal Aviation Administration 800 Independence Avenue, S. W. Washington, DC 20591	

15. Supplementary Notes

Work was accomplished under approved task AM-B-96-TOX-203

16. Abstract

A major concern in aviation medicine is the cabin inflight emergency that may result in the diversion of a flight. At the present time there is no convenient way to monitor the incidence of inflight medical emergencies because airline companies are not regularly required to report medical emergencies or resulting diversions. A survey of one major US airline revealed that one out of every one million passengers may be deplaned by an unscheduled landing because of a life-threatening medical emergency. During a two-year FAA survey of US domestic flights there were 2,322 inflight medical emergencies, averaging approximately three per day, which resulted in an annual diversion rate of approximately 9%. In a 1989 study, inflight emergencies among arriving passengers at the Los Angeles International airport were analyzed. During the six-month period of the investigation 0.003% of 8.5 million passengers developed symptoms in flight that required follow-up assistance on the ground, and 10% of these passengers required hospitalization. A survey of the status of inflight medical care aboard domestic US air carriers was undertaken to determine the impact of current changes in the airline industry. Information for the years 1990 to 1993 was obtained from two airlines and two inflight medical care delivery companies, representing a total of nine major US Part 121 air carriers. This sample accounted for approximately 65% of US domestic air carrier activity for the period 1990 to 1993. The information was reviewed to determine which category of inflight medical emergency occurred most frequently and which category accounted for the greatest number of diversions. The trend in the frequency of diversions for medical reasons was also assessed. The impact of inflight medical advice was then evaluated by comparing the number of diversions that resulted in hospitalizations to the number that did not. Our findings show that neurological, syncopal, and cardiac episodes respectively, were the most frequent categories of medical emergencies encountered inflight, while cardiac, neurological, and respiratory events, in that order, accounted for the most diversions. However, obstetrical-gynecological, cardiac, and neurological cases had the greatest probability of diverting. The diversion rate, expressed as a ratio of diversions to emergencies or diversions to enplanements, remained fairly constant. It appeared that flight crews complied with medical advice in 97% of cases, and diversions resulted in hospital admissions 86% of the time. Renewed interest in the problems of inflight medical care delivery from all segments of the air carrier industry and government has led to a great deal of research into the medical problems of patients flying with a variety of health problems. Several organizations are evaluating the inflight medical kit and its impact on medical care delivery inflight. Recently, the Air Transport Association and the FAA's Office of Aviation Medicine have independently formed working groups to investigate this topic. This increased level of interest should result in greater cooperation within the aviation industry and a deeper understanding of all aspects of the problem.

17. Key Words	18. Distribution Statement
Medical Care, Emergencies, Aviation	Document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	13	

Form DOT F 1700.7 (8-72)

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ACKNOWLEDGMENTS

The authors wish to thank the air carriers and inflight medical care delivery companies who voluntarily contributed the data that made this survey a success. Specifically, we acknowledge MedAire, Air Ambulance, American Airlines, and United Airlines. Without their cooperation and support, this work would not have been possible.

Inflight Medical Care: An Update

INTRODUCTION

At the present time, there is no convenient way to monitor the incidence of inflight medical emergencies, because airline companies are not regularly required to report medical emergencies or resulting diversions. A survey of one major US airline (Schoken, & Lederer, 1970) revealed that one out of every one million passengers may be deplaned by an unscheduled landing because of a life-threatening medical emergency. During a two-year FAA survey of US domestic flights (Hordinsky & George, 1991) there were 2,322 inflight medical emergencies, averaging approximately three per day, which resulted in an annual diversion rate of approximately 8.8%. In a 1989 study (Speizer, Rennie & Breton, 1989), inflight emergencies among arriving passengers at the Los Angeles International airport were analyzed. During the six-month period of the investigation, 0.003% of 8.5 million passengers developed symptoms in flight that required follow-up assistance on the ground, and 10% of these passengers required hospitalization.

There appears to be a renewed interest in the problems of inflight medical care delivery from all segments of the air carrier industry and government. There is a great deal of current research being conducted into the medical problems of patients flying with a variety of health problems. Additionally, several organizations are evaluating the inflight medical kit and its impact on inflight medical care delivery. Recently, the Air Transport Association and the Federal Aviation Administration's Office of Aviation Medicine have independently formed working groups to investigate this topic. This increased level of interest should result in greater cooperation within the aviation industry and a deeper understanding of all aspects of the problem.

In this study, a survey of the status of inflight medical care aboard domestic US air carriers was undertaken for the years 1990 to 1993. The information was reviewed to determine which categories of inflight medical emergency occurred most frequently and which categories had the greatest probability of resulting in a diversion. The impact of inflight medical advice was evaluated by comparing the number of diversions that resulted in hospitalizations to the number that did not. Changes in the frequency of inflight medical emergencies, and the associated diversion rate, were also examined.

METHOD

A survey of the status of inflight medical care aboard domestic US air carriers was undertaken to determine the impact of current changes in the airline industry. Information for the years 1990 to 1993 was obtained from two airlines and two inflight medical care delivery companies, representing a total of nine major US Part 121 air carriers. This sample accounted for approximately 64.6% of the total number of enplanements for US domestic scheduled air carriers during that time (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). Data from all nine air carriers were used whenever possible; however, in those situations where data from one or more sources was incomplete, specific information on the size and composition of the data subset is given. A total of 14,334 cases of inflight medical emergencies were reviewed to determine which category of inflight medical emergency occurred most frequently. A subset of 2,388 cases was studied, which included 190 diversions to determine the diversion rate for all categories of inflight medical emergencies. Another subset of 2,321 cases was used to find the diversion rate by category of emergency. Diversions generally resulted for two primary reasons: (1) an obvious serious medical problem requiring immediate hospitalization; or (2) the inability to properly assess or treat an on-board patient, with the resulting uncertainty of what to do. The trend in the frequency of diversions for medical reasons was also assessed. The effectiveness of inflight medical advice was then

evaluated by comparing the number of diversions that resulted in hospitalizations to the number that did not. This evaluation has been refined in subsequent studies where more detailed information was available on the outcome of the passenger (DeJohn, Veronneau & Hordinsky, in press).

RESULTS

Our findings show that neurological, syncopal, and cardiac episodes were the most frequent categories of medical emergencies encountered inflight, while cardiac, neurological, and respiratory events accounted for the most diversions. However, obstetrical-gynecological, cardiac, and neurological cases had the greatest potential of diverting.

Figure 1 summarizes the incidence of inflight medical emergencies by category from 1991 to 1993. The figure combines data from two airline companies and two inflight medical care delivery companies, representing a total of nine major US Part 121 air carriers. These airlines accounted for approximately 65% of all US domestic air carrier enplanements for the period (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). A total of 14,334 cases of inflight medical emergencies were studied. The top five categories in order of frequency were neurological, syncopal, cardiac, psychiatric, and respiratory. Other categories not shown, in decreasing order of frequency, included traumatic injuries, gastrointestinal, allergic reactions, obstetrical-gynecological, and ears-eyes-nose-and-throat; however, these categories appeared with much lower frequency than the five primary classifications.

Diversions resulting from inflight medical emergencies are shown in Figure 2. A diversion was defined as any flight that results in an aircraft landing at an airport other than the intended destination. The data were obtained from one airline company and one inflight medical care delivery company, representing six major US Part 121 air carriers. This sample accounted for approximately 23% of US domestic air carrier activity for the period 1990 to 1993, as reflected by the number of enplanements (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). A total of 171 diversions were identified. The five categories resulting in the greatest incidence of diversions were cardiac, neurological, respiratory, syncopal, and obstetrical-gynecological, respectively. Other categories not shown in Figure 2 included gastrointestinal, allergic reactions, psychiatric, and traumatic injuries, listed in decreasing order of frequency. The incidences of these categories were much lower than the five primary categories appearing in Figure 2. Finally, other residual causes, which are also not shown, accounted for 25 diversions during the period.

To determine which category of inflight medical emergency had the greatest diversion rate, the number of diversions was divided by the frequency of the respective category. The result is shown in Figure 3. The data for this figure were obtained from one airline company and one inflight medical care delivery company, representing six US Part 121 air carriers. These air carriers accounted for approximately 23% of all US domestic air carrier activity, as reflected by the number of enplanements for the period 1990 to 1993 (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). The categories with the greatest diversion rates were obstetrical-gynecological, cardiac, neurological, respiratory, and allergic reactions, in decreasing order of frequency. Categories not shown, with much lower diversion rates, were miscellaneous, psychiatric, syncopal episodes, injuries, and gastrointestinal also in decreasing order.

Approximately 8% of all flights studied diverted each year due to inflight medical emergencies. This was determined by dividing the number of diversions by the corresponding number of inflight emergencies, for all categories, for each year, and averaging the ratios over the period 1990 to 1993. The data were obtained from one airline company and two inflight medical care delivery companies, representing eight major US Part 121 air carriers. This sample accounted for almost half of all US domestic air carrier activity, as reflected by the number of enplanements for the period 1990 to 1993 (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996).

Figure 4 shows the variation in the number of inflight emergencies (solid), diversions (dashed), and the diversion rate (dotted). The data were collected from one air carrier and two inflight medical care

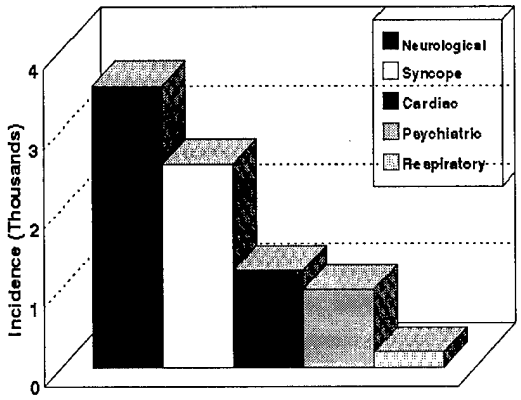

Figure 1. Incidence of Inflight Medical Emergencies.

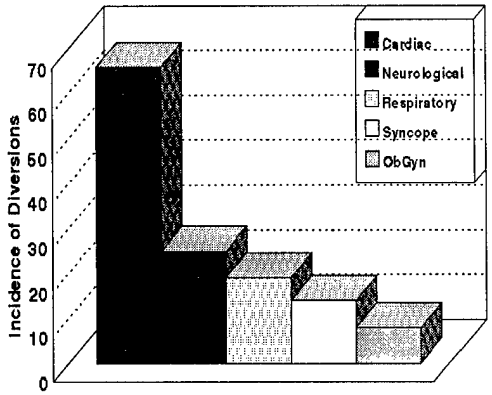

Figure 2. Incidence of Diversions by Category.

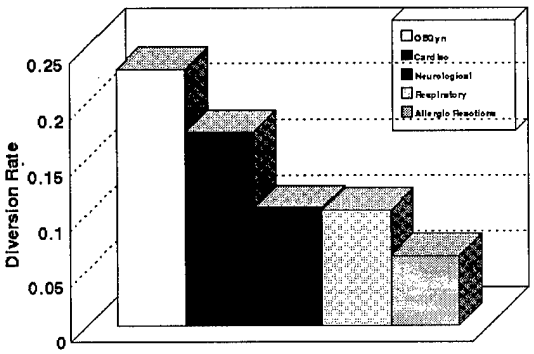

Figure 3. Diversion Rate by Category.

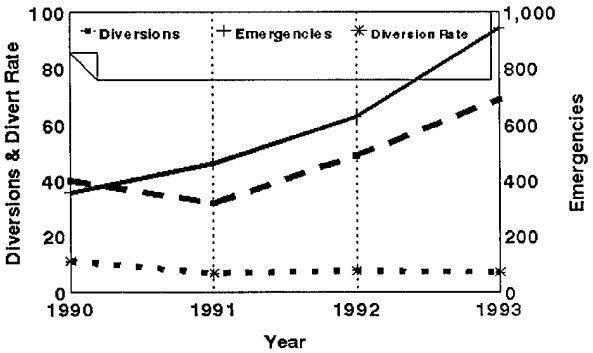

Figure 4. Inflight Medical Emergencies, Diversions, and Diversion Rate.

Inflight emergencies, shown by a solid line, are marked with a "+" symbol. Diversions, shown by a dashed line, are represented by a "■" symbol. Divert rate, shown as a dotted line, is demarcated with a "*" symbol.

delivery companies, representing eight major US Part 121 air carriers. This sample accounted for approximately 50% of all US domestic air carrier activity, as reflected by the number of enplanements for the period 1990 to 1993 (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). The figure shows that the number of inflight medical emergencies has generally increased over time, while the number of diversions decreased slightly from 1990 to 1991, then increased from 1991 to 1993. As a result, the diversion rate decreased slightly from 1990 to 1991, then remained essentially constant from 1991 to 1993.

The number of inflight emergencies was compared to the number of diversions over time by dividing each variable by the annual number of enplanements. Data for this figure were collected from one air carrier and two inflight medical consultation company representing eight US Part 121 operators. These air carriers accounted for approximately 50% of all US domestic industry activity, as reflected by the number of enplanements from 1990 to 1993 (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). The results are shown in Figures 5 and 6. While the number of enplanements (dashed) did not appreciably change with time, the emergency rate per hundred thousand enplanements (solid) more than doubled, as shown in Figure 5.

In Figure 6, the number of enplanements (dashed) remained essentially constant, while the diversion rate per hundred thousand enplanements (solid) decreased from 1990 to 1991, then doubled from 1991 to 1993.

Figure 7 shows data from one inflight medical consultation company representing five major US Part 121 operators. This sample accounted for approximately 10.7% of all US domestic air carrier activity, as reflected by the number of enplanements for these air carriers from 1990 to 1993 (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). Data in Figure 7 indicate that 97% of the time aircrews elected to comply with physicians' recommendations to divert. Also, hospital admissions followed diversions in 86% of cases.

The annual number of hospital admissions was divided by the annual number of diversions to evaluate the relationship between these variables over time. The results are shown in Figure 8. Data were obtained from one inflight medical consultation company representing five major US Part 121 operators. This sample accounted for approximately 11% of all US domestic air carrier activity, as reflected by the number of enplanements for the carriers from 1990 to 1993 (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996). For 1990 and 1991, all medical diversions surveyed resulted in hospital admissions. For 1992 and 1993, some diversions did not result in admissions. In 1992, 73.7% of medical diversions surveyed resulted in hospital admissions, while in 1993, 88% of surveyed diversions resulted in admissions.

DISCUSSION

Figures 1, 2, and 3 indicate that, although neurological emergencies were the most frequent, and cardiac emergencies accounted for the most diversions, obstetrical-gynecological emergencies had the greatest potential of resulting in a diversion.

The leading causes of inflight medical emergencies found in this survey (Figure 1), are similar to, but not identical to, categories found in other studies. Figure 9 compares the results of this survey with two other studies. One study evaluated all arriving passengers at Los Angeles International Airport (LAX) who made inflight medical complaints from October 1985 through March 1986 (Speizer, Rennie & Breton, 1989). Another study investigated the frequency and type of medical emergencies that occurred at the Seattle-Tacoma International Airport from September 1986 through August 1987 (Cummins, & Schubach, 1989). Each category in Figure 9 represents a percentage of the total of inflight emergencies for the respective study.

While Figure 9 shows most categories of inflight medical emergencies, it limits easy comparisons. Figure 10 is limited to the three categories with the greatest frequency in each study. It is apparent from examination of the figure that cardiac emergencies are common to all three studies. In addition, the top three categories found the in the Los Angeles and Seattle-Tacoma studies were identical and occurred with similar relative frequency.

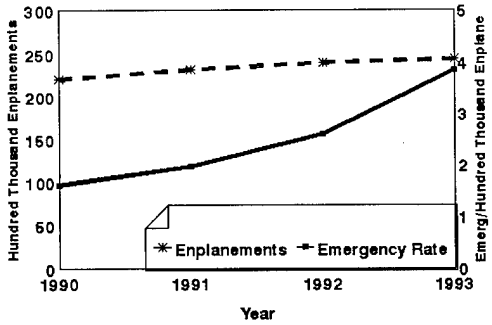

Figure 5. Inflight Medical Emergency Rate Per Hundred Thousand Enplanements.

The number of enplanements, shown by a dashed line, is represented by a "*" symbol. The emergency rate per hundred thousand enplanements, shown by a solid line, is marked with a "■" symbol.

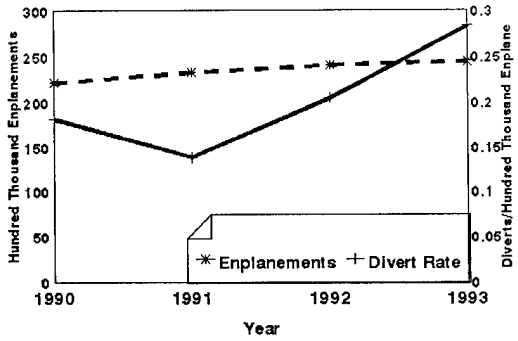

Figure 6. Diversion Rate Per Hundred Thousand Enplanements.

The number of enplanements, shown by a dashed line, are represented by a "*" symbol. The diversion rate per hundred thousand enplanements, shown by a solid line, are marked with a "■" symbol.

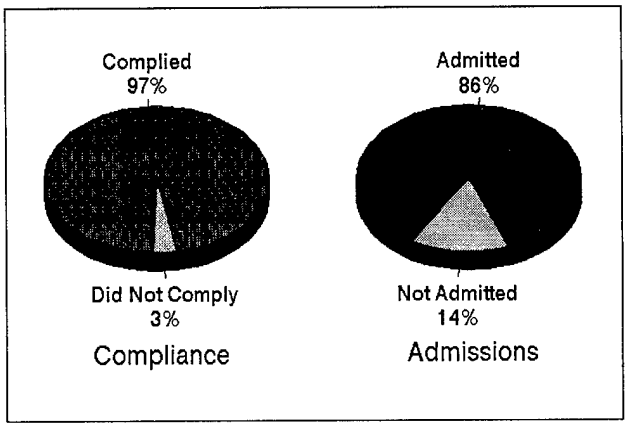

Figure 7. Diversion Compliance and Hospital Admissions.

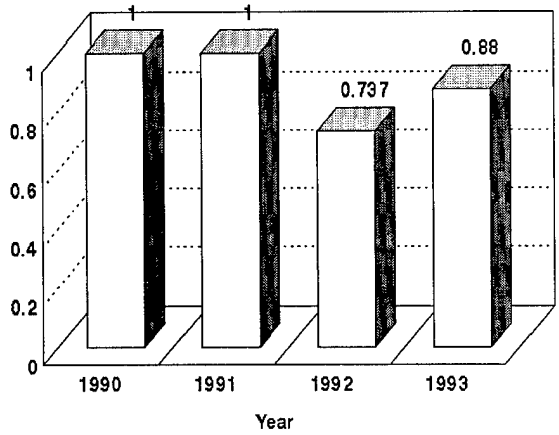

Figure 8. Hospital Admissions/Diversions Ratio.

The differences between these and other studies are probably due to differences in data collection methods and the classification of inflight emergencies. The CAMI study data included only inflight medical emergencies as reported by air carriers and inflight medical care providers, including hospital admission diagnoses. The LAX study surveyed arriving passengers who had voiced inflight medical complaints. Similarly, the SEA study surveyed passengers and others who reported medical problems while at the airport. When data were solicited for the CAMI survey, each source had its own classification system. Although forms were sent to companies requesting data in a standardized format, the suggested forms were never used. This presented problems categorizing and collating data.

Figures 4, 5, and 6 indicate that the diversion rate, expressed as a ratio of diversions to emergencies or diversions to enplanements, remained fairly constant. This is consistent with the data shown in Figure 11, where the average diversion rate from this study is compared to the rate found in the 1991 FAA study (Hordinsky & George, 1991). Data from one inflight medical consultation company represented five major US Part 121 operators. This sample accounted for approximately 11% of all US domestic air carrier activity, as reflected by the number of enplanements for the years 1990 to 1993. It can be seen from the figure that the rate did not change appreciably between the 1991 and 1995 studies and was equal to approximately 8% (US DOT, FAA, *Administrator's Fact Book*, July 1993 & April 1996).

The data in Figures 4, 5, and 6 also suggest that the incidence of inflight emergencies has steadily increased, while the incidence of diversions declined slightly from 1990 to 1991, then increased from 1991 to 1993. As a result, the diversion rate (diversions/emergencies), remained essentially constant, declining slightly from 1990 to 1991 and remaining at approximately the same level from 1991 to 1993. Enplanements did not appreciably vary during this period, implying that the increases in emergencies and resulting diversions are probably not explained by an increase in the number of airline passengers. While the reasons for the changes in the total number of emergencies and diversions are not clear, they may be related to an increase in the number of medically at risk passengers. There is evidence in the literature to support such an increase. Skjenna, Evans, Moore, Thibeault, and Tucker (1991) found that many people with medical conditions that would have previously precluded them from flying are now doing so. Gong (1992) stated that the number of patients flying is probably increasing annually.

There are at least two possible explanations for an increase in the number of medically at-risk passengers that are likely related to each other. First, the Americans with Disabilities Act (ADA) of 1990 addresses individuals with disabilities who are discriminated against and includes discrimination in the area of transportation (Americans with Disability Act, 1990). It states that no individual can be denied full access to public transportation on the basis of disability. The Act forbids eligibility criteria that screen out individuals with disabilities and defines a failure to make reasonable modifications in policies, practices, or procedures as discrimination.

Second, following the passage of the ADA, several studies were conducted, focusing on methods for decreasing risk and enhancing safety during air travel for passengers with various medical conditions (Berg, Dillard, Rajagopal & Mehm, 1992; Bia & Barry, 1992; Dillard, Beninati & Berg, 1991; Gong, 1991, 1992; Gong, Mark & Cowan, 1993). This research resulted in several technical advances, some of which included more reliable clinical assessment of oxygen needs and the availability of lightweight, portable, efficient oxygen delivery systems.

It appears that the ADA, subsequent research, and technical advances have resulted in an acceptance by the airlines of the concept of modifying policies, practices, and procedures as necessary to provide their services to passengers who are disabled. This has included many passengers who are medically at risk. While this is certainly beneficial to the 43,000,000 Americans who have one or more physical or mental disabilities (ADA, 1990), it may have accounted for increases in the numbers of inflight medical emergencies and related diversions.

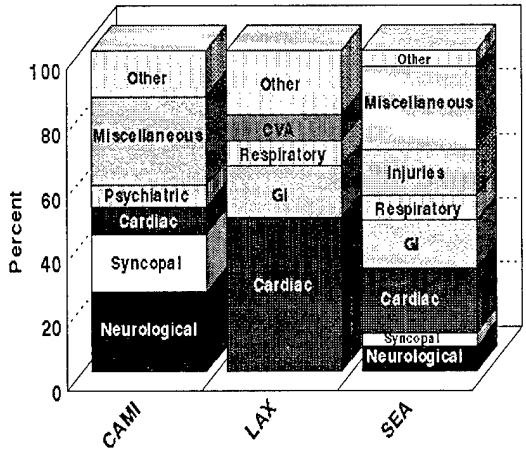

Figure 9. Leading Causes of Inflight Medical Emergencies.

CAMI represents the results of this study. LAX represents the results of the 1989 Los Angeles International Airport study conducted by Speizer, Rennie and Breton. SEA depicts the results of the 1989 Seattle-Tacoma International Airport study by Cummins and Schubach.

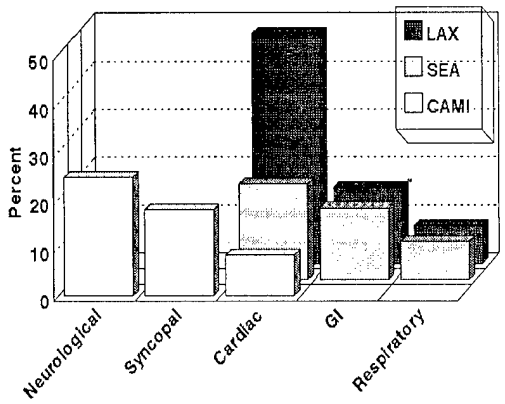

Figure 10. Three Leading Causes of Inflight Medical Emergencies.

CAMI represents the results of this study. LAX represents the results of the 1989 Los Angeles International Airport study conducted by Speizer, Rennie and Breton. SEA depicts the results of the 1989 Seattle-Tacoma International Airport study by Cummins and Schubach.

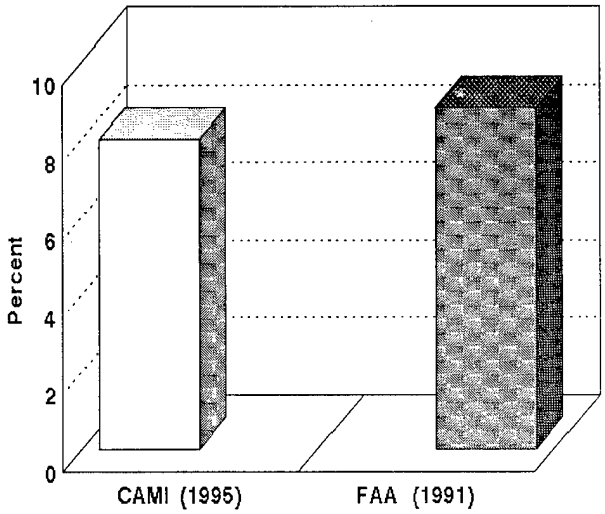

FIGURE 11. AVERAGE ANNUAL COMPOSITE DIVERSION RATE.

We now turn to the subject of flight crew compliance with inflight medical advice and resulting diversions for medical reasons, which was shown in Figure 7. It appeared that flight crews complied with medical advice in 97% of cases, and diversions resulted in hospital admissions 86% of the time; however, there are other considerations that may not have been apparent from an examination of the figure. The 3% of the time that flight crews did not comply with medical advice may not represent a decision to ignore the advice of medical professionals by flight crews. This small percentage of cases may represent unique situations where the recommendation to divert was a matter of record, but the circumstances onboard the aircraft dictated that this would not be the best course of action. For example, the recommendation to divert may not have been communicated in a timely manner. By the time it was received, continuation to the destination might have been in the best interest of the patient. Alternatively, the condition of the patient may have improved following the recommendation to divert, making the diversion unnecessary. Unfortunately, these data were not available for our survey, as it would have been helpful in analyzing if a decision to ignore a recommendation to divert was justified.

The adequacy of medical advice was examined in Figure 8 by analyzing the ratio between the number of hospital admissions and the number of diversions for medical reasons. It might appear that the ideal ratio would be "1.0." However, this is not necessarily the case. If the ratio is 1.0, this means that each diversion surveyed resulted in an admission, as was the case for the years 1990 and 1991. However, there may have been incidents where flights did not divert, but should have, possibly resulting in a hospital admission upon arrival at the destination. Such incidents would not be reflected in the diversion statistics and would not affect the ratio. This might imply that medical advice was too conservative, and the recommendation to divert should have included some cases that were not diverted. If the ratio is less than 1.0, not all diversions resulted in hospital admissions, implying that medical advice was liberal, and fewer cases could have been diverted. This was the case for the years 1992 and 1993. The "ideal" hospitalization rate, based on the number of diversions, should probably approach 1.0 but be slightly less than that. This would be slightly liberal and would ensure that all serious emergencies were appropriately diverted.

Some cases will, because of their nature, improve upon decent. This is especially true of certain pulmonary conditions, where the cabin pressure and partial pressure of oxygen increases as the flight descends for a landing. It might also include certain psychiatric cases that involve a fear of flying or enclosed spaces. In addition, there are a number of emergencies that are treated in flight where the patient's condition improves, and hospitalization becomes unnecessary. Examples include diabetics who are given insulin, or epileptics who are given anti-convulsants. The reader should understand that these treatment options are possible only if traveling physicians or patients have their own therapy source. Insulin and anti-convulsants, for example, are not available in the medical kits aboard US air carriers. There may not be a need for hospitalization when the patient arrives in the emergency room in such cases. Complete data on patient outcome, for diverted and non-diverted flights, would be required to evaluate diversion decisions. Unfortunately, these data were not available for our survey.

RECOMMENDATIONS

Future research on the quality of inflight medical care will require standardized, industry-wide data on the frequency of inflight medical emergencies and related diversions, including the cost of those diversions. Additionally, outcomes following hospital admissions are necessary to assess the appropriateness of inflight medical advice. This will require the cooperation of airline medical directors and directors of inflight medical care delivery companies. To obtain such cooperation, confidentiality and anonymity must be guaranteed through arrangements made prior to commencing research.

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