

# A Trial of Home Oxygen for Acute Asthma Attacks for the Prevention of Asthmatic Death

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## ABSTRACT

Physicians are very much concerned that death from asthma has not significantly declined despite modern treatment. Since most asthma deaths take place at home it is mandatory to keep in mind that adequate management should be commenced as early as possible at home when a severe asthmatic attack develops especially in high-risk patients.

For preventive care, the main objective should be to avoid severe hypoxemia with resultant cardiac arrest that may occur during severe asthmatic attacks at home and during transportation.

A total of 97 patients were studied with near-fatal asthmatic attacks requiring mechanical ventilation at least once during the period from January 1979 to November 1993, these patients were seen at Okinawa Chubu Hospital and survived without significant morbidity.

They were considered at high risk for recurrence of life-threatening asthmatic attacks and death and were therefore persuaded to undergo a trial of immediate self-oxygenation at home and during transportation to an emergency department whenever a severe attack developed.

Only 61 patients agreed to our request. Among those who agreed to install home oxygen, 24 subsequently developed severe attacks requiring mechanical ventilation outside hospital during following 15 years.

Sixteen of them immediately started oxygenation at home in addition to the anti-asthma medication, continuing the process all the way to emergency center; all survived.

Eight Patients did not actually take their home oxygen and four of them died ( $p < 0.05$ ).

Among the 36 patients who declined home oxygen trial, 13 experienced recurrences of severe asthmatic attacks outside the hospital; nine of them died.

Long-term follow up disclosed that 8.1 percent of those receiving home oxygen offered to them ( $n=61$ ) died from an asthmatic attack. On the other hand, 30.5 percent of those who refused to have home oxygen ( $n=36$ ) died within a 15 years period ( $p < 0.05$ ).

## KEY WORDS

asthma attack, asthmatic death, home oxygen, preventive care, severe hypoxemia

## INTRODUCTION

It is disturbing to find that the incidence of adult asthmatic deaths has declined minimally in recent years.<sup>1</sup> The mortality rates from asthma in a 1986 report by Benatar reviewing at least seven countries ranged from 1.3 to 8.0 per 100,000 in the general population with the highest rates being in New Zealand and South Africa (Figs. 1,2).

With the introduction in 1988 of inhaled corti-

costeroids as first line therapy for controlling chronic asthma, the fatality rate has slowly declined even in Okinawa Chubu hospital; however there are still a substantial number of high-risk patients who must be identified and protected from asthmatic death.

## MARKERS FOR HIGH RISK OF AN ASTHMATIC DEATH

Williams<sup>3</sup> followed 65 patients who had been intubated for an acute asthmatic attack. Over a period of

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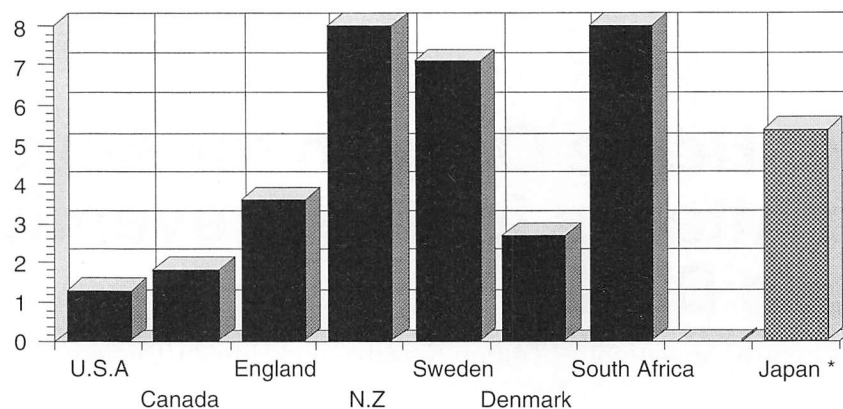
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Received 14 January 2004.

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**Fig. 1** Mortality Rate for Asthma per 100,000 persons in Various Countries including Japan (Benatar SR.1986, \*Mitsui M.1986)

one to 10 years, 22 had a recurrence of life threatening attacks requiring intubation ; four died, three had two subsequent recurrent episodes and three had three recurrences.

He concluded that even a single episode requiring intubation placed the patient at high risk for recurrence of life-threatening attacks and death.

Nowadays we usually see from 1,000 to 1,500 asthmatics a year in the emergency department at our 550-bed hospital.

In the 15 years from 1979 to 1993, we followed 97 asthmatic patients who in the past had one or more severe asthmatic attacks requiring intubation and mechanical ventilation.

They were considered at high risk for a future and fatal asthmatic attack, based on the experience of Williams.

### FATAL ATTACK PATTERNS

There are two types of fatal asthmatic attacks as defined by Benatar.<sup>2</sup>

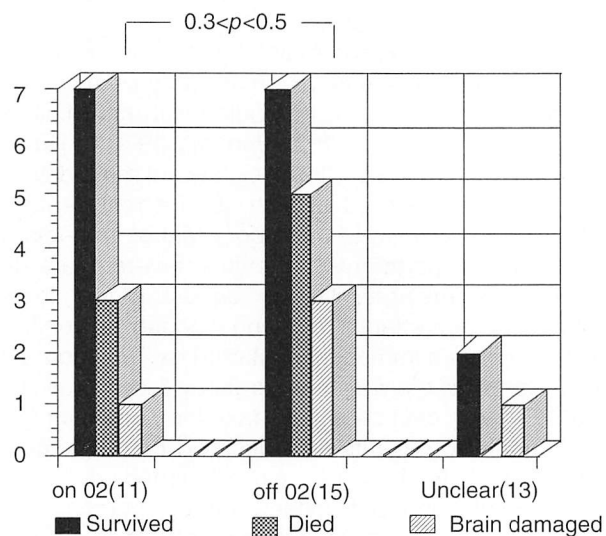
One is a sudden death after a very short course and usually in patients with a large diurnal variation in the peak flow rate.

The other occurs less suddenly during a prolonged exacerbation of a mild attack which is preceded by a weeks of poor control, ending with exhaustion and muscle fatigue.

The severity of eventually fatal attacks is usually not correctly assessed initially.

At Okinawa Chubu hospital, 67 asthma fatalities were seen in the 15 years from 1979 to 1993 and 90 percent of the fatal attacks occurred so rapidly that adequate emergency room management could not be instituted in time to be effective.

In our experience, a short interval between the onset of symptoms and the arrival at the emergency facility may not prevent a fatal attack because 40 percent were brought to the emergency room within one hour and 20 percent within three hours of their acute



**Fig. 2** Outcome of Patients with CP-Arrest on or off O<sub>2</sub> during Transportation (N=29)

symptoms.

About one third of those who died developed a sudden exacerbation after only a mild attack at home. Cardiopulmonary arrest was considered to have occurred at home in 37 percent, in the ambulance in 36 percent, and in the family car or taxi in 12 percent.

Attempts at cardio-pulmonary resuscitation (CPR) on patients reaching the emergency room who had had a cardiac arrest at home or during transportation were uniformly unsuccessful.

### THE EFFECT OF OXYGEN ONLY DURING TRANSPORTATION TO HOSPITAL

CPR was performed on 21 patients who had had respiratory arrest without cardiac arrest during their acute asthmatic attack. None of these patients expired, irrespective of oxygenation during transportation.

We had 29 patients who had a complete cardiopulmonary arrest, of whom 13 expired, only half of whom had been oxygenated while being transported to the hospital.

There was no statistical difference in mortality between those patients that were oxygenated and those that were not oxygenated who eventually suffered cardiopulmonary arrest (Fig. 2).

These experiences suggested to us that it was essential to give oxygen as early as possible during a severe asthmatic attack with the objective of preventing a cardiac arrest secondary to marked hypoxemia ( $\text{PaO}_2 < 20$  Torr).

### PRIOR FATAL ATTACK PREVENTION STUDIES

A report on a large-scale trial in Edinburgh by Crompton in 1979 showed that they reduced mortality rate of fatal asthmatic attacks by one-third over a period of 10 years by concentrating the treatment of all acute asthmatic attacks at one center (4).

A six-month study was carried out by Barriot<sup>5</sup> in 1987 in Paris, in which an immediate telephone call at onset of severe asthmatic attack from the patient or family member, resulted in the arrival of medical emergency aid within 10 minutes, and a physician within 30 minutes. Asthma fatality rates were reduced by about 85 percent when compared with the rate of the previous six months.

The reduction in mortality resulting from the Barriot trial in which treatment was initiated as early as possible during an acute asthmatic attack, and the Edinburgh trial which supplied early and optimum treatment to such patients, encouraged us to institute a trial of oxygenation at the site of the acute attack as well as during transportation to the hospital.

### THE HOME OXYGEN STUDY AT OKINAWA CHUBU HOSPITAL

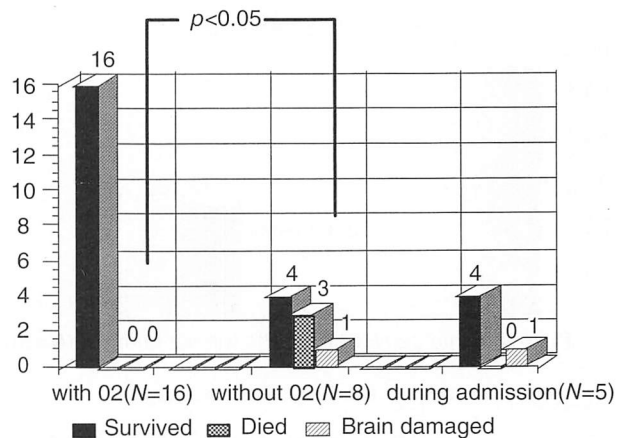
#### MATERIAL AND METHOD

The 97 patients (44 male and 53 female, average age of  $39 \pm 9$  and  $46 \pm 22$  years, respectively), satisfied the American Thoracic Society criteria for the diagnosis of asthma.<sup>6</sup>

They were considered to be at high risk for a future fatal asthmatic attack because they have required previous mechanical ventilation at least once.

They were offered a program in which they were told to immediately begin combined oxygenation and anti-asthma therapy at home at the onset of an attack of severe asthma.

They were then to maintain oxygen inhalation while being transported by car or ambulance to the hospital. A severe asthmatic attack was defined as one associated with severe wheezing and dyspnea, especially with the appearance of cyanosis or a pulse rate of over 130 and diaphoresis, inability to lie supine.



**Fig. 3** Outcome of Life-threatening Episodes by High-risk Patients having Home Oxygen (N=29.....24 at home / 5 during admission)

**Table 1** Comparison of recurrence and Outcome of the Episodes of asthmatic Attacks between Those with and without Home Oxygen

No. of Pts.	Recurrence (%)	fatality or brain damage (%)
with home O <sub>2</sub> (N=61)	29(47.5%)	5(17.2%)
without home O <sub>2</sub> (N=36)	15(41.6%)	11(73.3%)*

\* $p < 0.001$

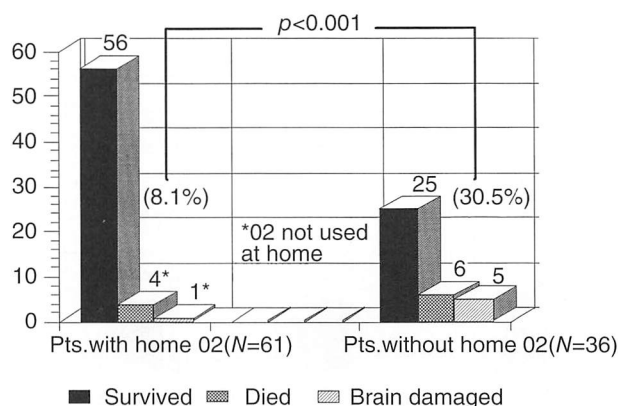
They were required to purchase two large cylinders of compressed oxygen gas and one portable small cylinder with carrying devices.

### RESULTS

Only 61 of the 97 high risk patients agreed to this home oxygen program. The remainder who refused for various reasons served as an incidental comparison group.

Over a period of 15 years, 29 of the 61 patients (47%) who had agreed to home oxygen therapy experienced recurrences of life-threatening asthmatic attacks; 24 of the recurrences occurring outside hospital and five during hospitalization. One of the five who had a recurrence during hospitalization died after suffering severe anoxic brain damage (Fig. 3).

Sixteen of the patients whose recurrences of severe asthmatic attacks happened at home had utilized the home oxygen protocol. None of these 16 who followed our instructions to use oxygen for acute attacks died. Although the 24 patients with life-threatening recurrences outside of hospital had agreed to home oxygen therapy, eight of them had not actually used oxygen at home and during transportation to the hospital as instructed. Therefore they also served as another incidental comparison group. Of these eight, four died during transportation.



**Fig. 4** Long-term Outcome of High-Risk Patients with or without Home Oxygen in 15 Years (1979–1993)

Although the recurrence rate was 47.5 percent and the recurrence mortality (5 of 29 patients with a recurrence) was 17.2 percent, the overall mortality rate of the entire group of 61 patients, including those who did not utilize the oxygen at home, was 8.2 percent.

Our other comparison group was made up of the 36 patients who refused the home oxygen therapy. Of these, 15 (41%) had recurrences of acute attacks and 11 died (recurrence mortality 73%, over all mortality 30%): two of them expired during hospitalization. Thus, although the recurrence rates of both groups that had agreed or not agreed to home oxygen use were not statistically different (47.5% vs. 41.6%), both their recurrence mortality and over all mortality rates were remarkably different (Table 1). Indeed when comparing the mortality rates for recurrent acute asthmatic attacks between those who actually used home oxygen therapy for their acute attacks at home and during transportation to the hospital and those who did not, was 0 percent (0/16) vs. 50 percent (4/8) even in high risk patients having home oxygen (Fig. 3).

Using intention to treat as a judge of the efficacy of “on-the-spot” oxygen therapy, long-term mortality was 8.1 percent, compared with 30.5% in the patients having declined to have home oxygen over a period of 15 years (Fig. 4).

However, we speculate that, if all the patients who had agreed to use home oxygen had actually used it at the onset of their eventually fatal attack, the mortality in this group may have been much lower.

## DISCUSSION

Among recent advances in treating chronic asthma are the changes in first-line treatment, from bronchodilators such as round-the-clock administration of oral methylxanthines and metered dose inhalation of

beta-agonists on a regular basis, to the use of anti-inflammatory agents such as inhaled corticosteroids. Despite these changes, the incidence of asthma deaths has failed to decline and in some countries appears even to be increasing.<sup>7</sup>

Benatar’s seven-country study of asthma mortality did not include Japan.<sup>2</sup> Mitsui in 1986 reported that Japan had an asthma death rate that was fourth among the industrialized countries with more than 6,000 deaths in a year.<sup>8</sup> Therefore, we were keenly interested in any trials that would lower this substantial mortality rate. We began with the search for methods to identify high-risk patients, and then conducted our home oxygen program on such patients. We feel that, although we had considerable success in reducing the mortality of this high-risk group, our optimism was tempered by the finding that over the same 15 years of our study there were more than 20 patients who died at Okinawa Chubu Hospital and who were not classified as high risk patients because they never had had a previous life-threatening asthmatic attack requiring mechanical ventilation. The fact that they died of their first severe attack suggests the obvious conclusion that our criteria for high risk mortality was inadequate. The criteria should probably be expanded to include patients with a large diurnal variation in peak flow rate and patients under poor control for any reason. In conclusion, the use of oxygen at home should be recommended not only for those at obvious high risk based on their previous need for mechanical ventilation but also for those patients who despite being offered maximum medical therapy are still under poor control and potentially at high risk. Further large scale trials of home oxygen for acute asthmatic attacks are necessary to confirm our results.

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