

Nocturnal cough in asthma

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SUMMARY The timing of nocturnal cough and its association with change in ambient temperature was documented in 11 asthmatic children, median age 5.1 years, while they were receiving continuous prophylaxis. Studies were performed in their homes on three nights. A voice activated system with electronic time signal recorded coughing. Ambient temperature was recorded every five minutes throughout the night on a Grant Squirrel data logger. Ten children coughed on 27 nights with a median of six bouts of coughing a night (range 0–272). The cough rate in the two hours after going to bed was significantly higher than the cough rate in the middle of the night (2–4 am or 4–6 am). Peak coughing times were 7–9 pm and 6–8 am. The room temperature was lowest between 5 and 7 am. There were no significant differences between cough rates during periods of rapid temperature change (more than 1°C an hour). The timing of nocturnal cough observed in this study differed from the known basophase of circadian cycles described for adults and children.

Coughing is a common nocturnal symptom in children with asthma that has received little attention even in laboratory based studies.^{1 2} Its association with other symptoms of nocturnal asthma and with circadian changes in lung function is unknown. There is evidence that symptoms are worst when peak expiratory flow rates are lowest, usually between 2 and 5 am,³ but there is no published information, to our knowledge, on the precise timing of cough. We therefore documented the timing of cough during the night in asthmatic children on maintenance prophylaxis for asthma. We also recorded ambient temperature trends in the bedrooms of these children, as such data are not currently available.

Patients and methods

Eleven patients attending the paediatric respiratory clinic at this hospital with moderate to severe asthma and night time coughing were invited to participate in the study. In seven the daytime control of asthmatic symptoms was good; daytime and nocturnal symptoms were present in the remaining four. Their median age was 5.1 years (range 2.7 to 10.5) and only two were over 6 years. Five children were taking regular inhaled or oral steroids, two sodium chromoglycate, and three the theophylline preparation, Slo-Phyllin. All were taking regular selective β_2 -agonists. In each case the last dose of medication was taken at bedtime.

The studies were performed in the patients' homes on three (usually consecutive) nights. No attempt was made to change the child's normal bedtime environment. No child slept with feather pillows or quilts, and there were no pets in the bedrooms. We did not measure housedust mite population or the humidity of the room. Equipment was set up and checked each night. The system for recording coughing was based on previously described cough recorder systems.^{4 5} A directional microphone was placed near the bed. A voice activated switch started a UHER 4200 tape recorder at noise above a threshold level which had been set individually for each child. An acoustic delay link ensured that the recorder was at operating speed by the time the triggering noise reached the tape recorder. After the noise stopped an electronic time signal was automatically recorded on a second channel of the tape recorder and the tape stopped. The tape was checked each morning to ensure that data had been recorded. One tape usually held three nights' recordings. The tapes were analysed simultaneously aurally and through a BBC computer which 'listened' to the tape in 10 second epochs. For each epoch of noise, the operator could record whether the data were due to coughing. The time of that epoch was then decoded, displayed, and stored.

Ambient temperature was recorded and stored using a Grant Squirrel data logger SQ32.2U 2U programmed to take readings at preset intervals of five minutes throughout the night. The probe

recorded temperatures within the range -5 to $+45^{\circ}\text{C}$ and was calibrated against a mercury and glass thermometer of resolution 0.1°C . The data were retrieved through a BBC computer which gave full lists of data and trend graphs. The results were

analysed by the Wilcoxon matched pair signed rank tests.

Results

Eleven children were studied on 33 nights. One child did not cough at all. The remaining 10 children coughed on 27 nights with a median of six epochs (range 0–272) of coughing per night. Scrutiny of individual results showed a pattern in which most coughing occurred shortly after going to bed and before rising. We therefore arbitrarily divided the night into three periods: two hours after going to bed; two hours before rising; and the remainder of the night. The cough epoch rate per hour in the two hours after going to bed was significantly higher than during the rest of the night ($p < 0.05$) but no different from the two hours before rising. Fig 1 shows that the rate in the two hours after going to bed was also significantly higher than the rate during the time periods 2–4 am ($p < 0.05$) and 4–6 am ($p < 0.05$). The increase in the rate of coughing in the two hours before rising was not significant.

The data were then examined in real time. The children went to bed and rose at different times, giving a coughing pattern throughout the night. When the number of nights during which coughing occurred was expressed as the percentage of the nights that children were in bed at that time—that is allowing for different bedtimes—two peaks emerge—from 7–9 pm and 6–8 am (fig 2). Although there was variation in coughing times from night to night for individual children, five coughed predominantly in the first half of the night; one in the second half, and four intermittently throughout.

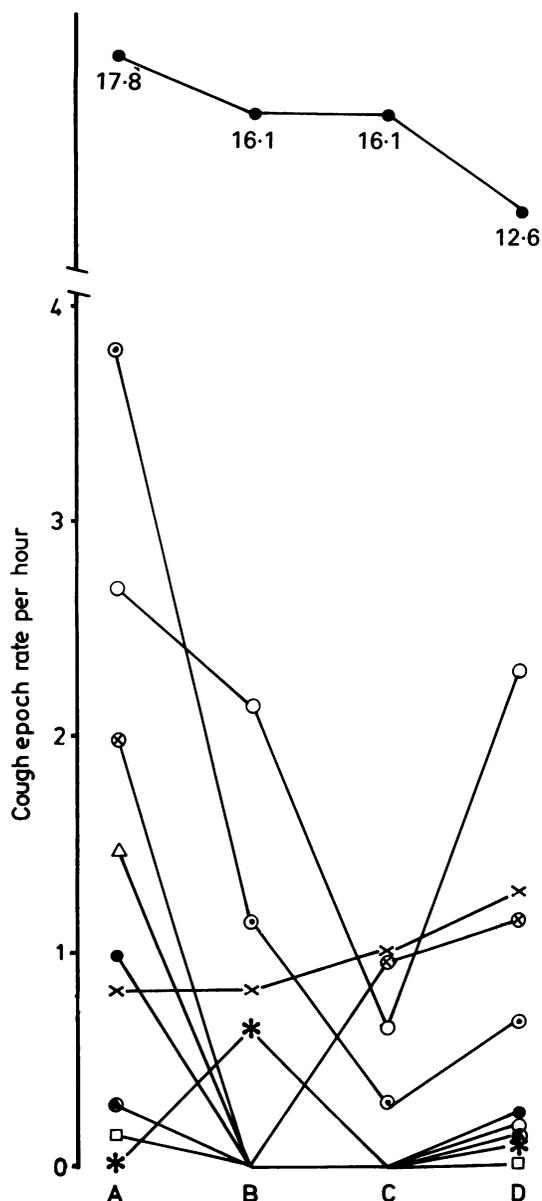


Fig 1 Cough epoch rate/hour for individual cases during four two hour time periods. (A=two hours after going to bed; B=2–4 am; C=4–6 am; D=two hours before rising.)

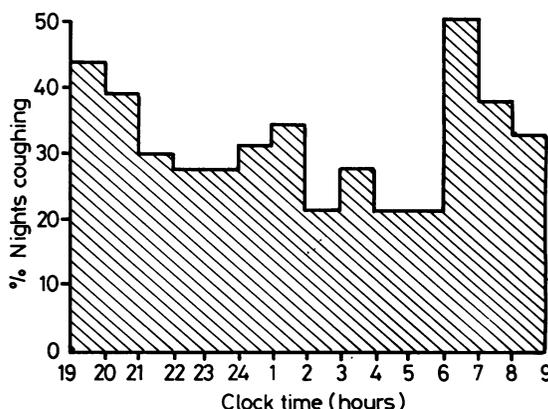


Fig 2 No of nights when coughing occurred expressed as % of no of nights during which observations were made at any particular hour.

The children took their regular drugs during the study. With two exceptions these were given within 90 minutes of bedtime (the exceptions were at our request early in the study and on both occasions the children required drugs during the night). On 11 nights coughing occurred within two hours of the regular drugs being given; on 18 nights within four hours; on 21 within six hours, and on 22 within eight hours. Two children used additional drugs during the night (four nights). This coincided with the end of a period of coughing that recurred after a mean of 64 minutes.

The mean (SD) ambient room temperature was 18.4°C (1.95) (range 14.4–21.8). The minimum temperatures usually occurred between 5 and 7 am. We calculated the change in temperature during each hour. There were no differences between cough epochs occurring when there was a change in temperature of greater than 1.0°C in an hour and in those when the temperature change was less than 1.0°C in an hour when paired comparisons were made for each child.

Discussion

Parental recording of nocturnal cough scores has been shown to be a poor reflection of actual events.⁴ All recordings were made in children whose parents had reported troublesome night time coughing, yet the median number of cough epochs per night was only six. Part of the explanation for this apparent disparity may lie in the timing of night time cough shown by this study. The parents may have been most aware of their children's coughing in the hours before they themselves retired and again in the hours before rising.

The timing of cough was an unexpected finding in our study. Although there are no directly comparable data on coughing, nocturnal events have been studied in children with asthma. Kales recorded awakenings with asthmatic symptoms in a temperature controlled (<20°C) sleep laboratory in 10 children on 20 nights.¹ The events were not reported in real time but no awakenings occurred in the first four hours after sleep had started and they were then evenly distributed throughout the remainder of the night, with few events occurring in deep sleep (stages 3 and 4). Smith and Hudgel showed a fall in forced expiratory volume in one second when asthmatic children were awakened at 3 am compared with values at 9 pm and 6 am, and maximum falls in oxygen saturation were greater from 2am–3 am than in the first hour of sleep.²

Maximum respiratory flows derived from flow volume loops were greater at 5–6 pm than 8–9 am,⁶ and a significant rhythm in peak flow recordings was

found in 14 of 64 children with symptoms of asthma with a bathyphase from 11 pm–4 pm.⁷ Circadian rhythms have also been shown in the airway resistance of normal children with acrophase 3.30–5.30 am.⁸ These findings suggest that children are most vulnerable to asthmatic attacks in the middle of the night. Surprisingly, the frequency of coughing was greater at the beginning and end of each night. In the studies quoted above coughing was not recorded as a separate variable, and its exact association with other signs and symptoms of nocturnal asthma remains unknown.

Several explanations are possible. The children we studied were younger than those in previous studies. Children under 6 can seldom perform conventional lung function tests, which explains the absence of data on circadian events in this age group. Coughing at night may be influenced by factors other than bronchial reactivity; and part of the explanation may lie in the sleep pattern. The influence of sleep stage on coughing in asthmatic children is unknown, but in adults with chest disease coughing is most common when awake and least common during deep sleep.⁵ In home based studies it is not possible to define sleep stage or to determine exactly when children fall asleep. It is possible that early coughing occurred when the children were awake, but unlikely that they took up to two hours to fall asleep in their own environment; even in a sleep laboratory children took only 24 minutes to fall asleep on the first night and seven minutes after settling on the third night.¹ There is also a decrease in mucociliary clearance during sleep in both normal subjects and in asthmatics, which may be relevant to the timing of coughing bouts throughout the night.⁹

Temperature was the only environmental factor studied which might have influenced coughing at night. Previous studies have found no association between respiratory symptoms reported by the parents and low temperature in the bedroom.^{10 11} This study was not designed to determine the influence of ambient temperature on nocturnal coughing, but our observations suggest that changes occurring within the range measured did not influence the frequency of coughing. Controlled observations in a laboratory are therefore necessary.

The children studied were all moderate to severe asthmatics who were receiving continuous treatment. Even so, parents reported nocturnal coughing. Of the three most severely affected children, two had poorly controlled daytime symptoms and the third, whose daytime control was good, coughed mainly during the early part of the night. The timing of treatment did not greatly influence the timing of cough, which usually oc-

curred within two hours of medication. The pattern of coughing on the five nights when theophylline was taken at bedtime did not differ significantly from that on other nights. On two occasions at the start of the study parents were instructed to omit the bronchodilator or theophylline, or both, at bedtime and each time treatment was required during the night. The pattern of coughing in individual children did not change on nights when treatment was given at bedtime. Bronchodilators given during the night seemed to halt coughing spells, but the effects were temporary. The timing of symptoms shown by this study, with peaks of coughing some 12 hours apart, lends support to the idea that improving 24 hour asthmatic control will minimise nocturnal symptoms.¹²

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