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Late respiratory sequelae of blunt chest injury: a preliminary report

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ABSTRACT Eighty-six survivors of blunt chest injury were assessed for pre- and post-injury respiratory symptoms using a standardised questionnaire. A comparison was made between observed and expected symptom prevalence and lung function. Respiratory symptom prevalence after injury was greater than expected, 23 survivors (27%) claiming a persistent productive cough, 18 (21%) persistent wheezing, and 22 (26%) grade 2 dyspnoea. After injury persistent productive cough ($p < 0.05$) and occasional wheezing ($p < 0.01$) were more common among smokers and ex-smokers when compared with non-smokers. Mean forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) were not statistically different from expected values. We concluded that respiratory sequelae of blunt chest injury are common and that smokers and ex-smokers are at particular risk.

Blunt chest injury is one of the more serious injuries associated with the current epidemic of road traffic accidents.[1] Mortality has been well documented and has remained at 20–25% in most reported series.[2 3] Morbidity and late respiratory sequelae have received less attention. The majority of such studies[2 4 5] have assessed disability by a comparison of spirographic and other lung function tests with "normal" predicted values. Spirometry correlates poorly with exercise tolerance[6] and may thus be an inadequate measure of disability especially when it is slight. Davidson and colleagues[2] in their study of the late effects of blunt chest injury concluded that "there was a strong impression that many patients were affected by respiratory symptoms to a degree not indicated by the objective tests." Respiratory disease and its usual cause, tobacco smoking, are common within the population. In the West of Scotland in 1973 21% of working men and 13% of women had a productive cough[7]. Only 20% of men and 44% of women in the United Kingdom had never smoked in 1975.[8] Both respiratory disease and smoking habits are distributed unevenly through the population. Any assessment of respiratory function must necessarily take account of these factors.

The present study using a standardised questionnaire, was undertaken to determine the degree of respiratory disability in a group of survivors of blunt chest injury and the influence thereon of pre-existing respiratory disease and smoking habits.

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Patients and methods

All patients with a blunt chest injury admitted to the Intensive Therapy Unit (ITU) of the Western Infirmary, Glasgow between 1968 and 1976 were admitted to the study. Management had been undertaken by the same group of consultants throughout, and all used the same principles. Personal data and details of injury, complications, and treatment were abstracted from the case records and recorded on a proforma. A pilot study had indicated that the ITU case records were more than adequate. Approval was granted by the hospital ethical committee and strict confidentiality was maintained throughout.

Survivors were traced and invited to attend for review. Those unable to attend were visited in their homes or, in the case of two subjects who had emigrated, seen locally by colleagues. Respiratory disability was assessed by a modified Medical Research Council (MRC) Respiratory Symptoms Questionnaire.[9] Subjects were asked to recall their pre-injury symptoms, and then to record their present symptoms, together with a comprehensive occupational and smoking history (appendix). FEV_1 and FVC were obtained with a wedge spirometer (Vitalograph, Buckingham, England,) the best of three technically satisfactory attempts being corrected to BTPS and recorded for analysis. The accuracy of

the wedge spirometer was verified against a bell spirometer (Pulmotest, Godart, De Bell, Holland). A clinical examination, including standing height and weight, was conducted and the extent of thoracic cage deformity and other physical disability noted. Whenever possible, the interview and lung function tests were conducted by EL and the clinical examination by CH, both of whom had trained in the use of the questionnaire.

The expected symptom prevalence, smoking habits, and lung function for the study group were predicted from age, sex, and smoking habit specific data determined in occupational and general population surveys of the Glasgow area conducted by the Department of Epidemiology and Preventive Medicine, University of Glasgow[7] (Hawthorne, VM, personal communication 1978). Symptom prevalence and lung function for ex-smokers in the study group were similar to those noted in smokers. Ex-smokers have, therefore, been treated as smokers throughout the study.

Student's *t* test and chi-squared analysis with Yates's correction have been used to test for significance where appropriate

Results

A total of 136 patients with blunt chest injury were admitted during the study period. Thirty (22%) died as a result of their injuries and a further 16 (12%) died later from unrelated causes. Eighty-six of the 90 survivors (96%) were traced and interviewed. The mean duration of follow-up was 4·6 years (range seven months to nine years). There was no significant difference in the duration of follow-up between males and females and smokers and non-smokers. No correlation could be found between duration of follow-up and symptom prevalence. The extent of thoracic and other injuries and treatment are summarised in table 1.

Physical characteristics, lung function values, and smoking habits are shown in table 2. The observed smoking habits, height, and weight did not differ significantly from those of the general population. There was no statistically significant difference between observed and expected mean values of FEV_1 and FVC.

The observed and expected prevalence of selected groups of symptoms for smokers and non-smokers are shown in tables 3 and 4 respectively. The symptoms of chronic bronchitis, cough, phlegm, and wheezing were restricted almost entirely to smokers

Table 1 *Injuries and treatment of patients with blunt chest injury admitted to the Intensive Therapy Unit, Western Infirmary, Glasgow, 1968–76.*

	Survivors	*Late deaths*	*Early deaths*
Number	90	16	30
Pulmonary contusion	64	10	21
Flail segment	55	9	25*
Cardiac injury	17	3	12*
Head injury	35	10	20*
Abdominal injury	9	1	9
Pelvis injury	22	3	6
Limb injury	34	9	23*
IPPV number	55	10	27*
duration days (±SD)	12±9·1	14±11·6	10·6±9·7

IPPV=intermittent positive pressure ventilation.
*p < 0·05 compared with early survivors.

Table 3 *Observed and expected symptom prevalence in smokers and ex-smokers. Question numbers are those of the MRC Respiratory Symptoms Questionnaire 1976, see appendix.*

Number	*Pre-injury 64*		*Post-injury 66*	
	Observed	*Expected*	*Observed*	*Expected*
Persistent cough and phlegm Q3 and 6	15	12	22	12
Occasional wheezing Q9a	18	17	35*‖	18
Persistent wheezing Q9a and b	7	8	17	8
Dyspnoea grade 1 Q8a	17	11	42‡¶	12
grade 2 Q8b	3	5	18†§	5
grade 3 Q8c	1	0	11*‖	0

*p < 0·05 †p < 0·005 ‡p < 0·001 compared with pre-injury prevalence.
§p0·05 ‖p0·005 ¶p0·001 compared with expected prevalence.

Table 2 *Physical characteristics and lung function of survivors of blunt chest injury*

	Number	*Age at interview (yr) Mean (range)*	*Height cm Mean (±SD)*	*FEV_1(l) Observed mean (±SD)*	*FEV_1(l) Predicted mean (±SD)*	*FVC(l) Observed mean (±SD)*	*FVC(l) Predicted mean (±SD)*
Male							
Smokers	53	48·6 (21–76)	169·6 (±8·59)	2·97 (±1·09)	2·92 (±0·56)	3·95 (±1·22)	4·13 (±0·71)
Non-smokers	12	45·5 (19–82)	170·7 (±7·7)	3·03 (±1·06)	3·29 (±0·61)	3·96 (±1·28)	4·62 (±0·52)
Female							
Smokers	13	54·5 (26–74	154·2 (±4·2	1·69 (±0·64)	1·72 (±0·45)	2·31 (±0·6	2·39 (±0·43)
Non-smokers	8	52·4 (29–82)	158·1 (±10·5)	2·07 (±0·99)	1·84 (±0·5)	2·76 (±1·22)	2·53 (±0·43)

Table 4 *Observed and expected symptom prevalence in non-smokers. Question numbers are those of the MRC Respiratory Symptoms Questionnaire 1976, see appendix.*

Number	*Pre-injury* 22		*Post-injury* 20	
	Observed	*Expected*	*Observed*	*Expected*
Persistent cough and phlegm Q3 and 6	0	1	1	1
Occasional wheezing Q9a	0	2	1	2
Persistent wheezing Q9a and b	0	0	1	0
Dyspnoea grade 1 Q8a	1	2	8*	2
grade 2 Q8b	0	1	4	1
grade 3 Q8c	0	0	2	0

*$p < 0.05$ compared with pre-injury prevalence.

both before and after injury and did not differ significantly from the expected prevalence. An overall trend of increasing prevalence after injury was apparent but statistical significance was not reached for every symptom. The prevalence of occasional wheezing after injury was particularly high, being claimed by over half 35/66) of the smokers and ex-smokers ($p < 0.01$) but by only one female non-smoker.

The symptom of dyspnoea was common after injury and showed a three-fold increase ($p < 0.005$) over the expected and pre-injury prevalence. There was some evidence to suggest that the increase was greatest among smokers particularly for grades 2 and 3. However, the small overall numbers did not permit a meaningful analysis. Thirteen (15%) of the survivors claimed grade 3 dyspnoea—that is, having to stop for breath while walking at their own pace on level ground.

Discussion

Respiratory symptoms, although subjective, are a more sensitive indicator of respiratory disability for groups of patients than spirometry. The increased respiratory symptom prevalence observed in these survivors of blunt chest injury suggests that respiratory disability, although often slight, is common after thoracic injury. The close correlation of observed and expected values for FEV_1 and FVC confirms the lack of sensitivity of such investigations in determining disability. The present study, which combines features of both cross-sectional and longitudinal studies, cannot determine whether the disability is static or progressive nor the influence of any progression on the observed prevalence. However, the lack of correlation between symptom prevalence and duration of follow-up and the use of age-specific prevalence rates for comparison suggests that the observed increase in symptom prevalence represents an increase in respiratory disability.

Accurate recall of pre-injury respiratory symptoms and smoking habits is important in determining the degree of selection in a particular group and its comparability with the general population. Previous reports[10 11] have suggested that respiratory symptoms and smoking habits are recalled poorly, but the supposition is unconfirmed with regard to respiratory symptoms. Experience suggests that individual recall may be highly inaccurate but in a group, recall is adequate for determining pre-injury disease. The hypothesis is based on a number of factors. First, the reasonable correlation between observed and expected pre-injury symptoms. Second, the patients have each experienced a significant "life event," their accident, thus providing a reference point on which to base their recall. Third, the questionnaire was structured so as to maximise the likelihood of accurate recall. The study of Holland *et al*[12] has shown that if two similar questionnaires are administered consecutively, then the response to the second is modified by the answers given to the first. The pre-injury status was determined first in the present study so that any bias would tend to reduce differences in symptom prevalence.

An increase in respiratory symptoms, in particular productive cough and wheezing, after blunt chest injury is more common in smokers than in non-smokers. The increased prevalence of wheezing in smokers is presumably related to an increased bronchial reactivity rather than to permanent airway changes since mean $FEV_1/FVC\%$ was within predicted limits. Increased bronchial reactivity to inhaled methacholine has been noted in the survivors of adult respiratory distress syndrome[13] and was most marked in smokers.

The distinction between smokers and non-smokers was less apparent when the symptom of dyspnoea was considered. The discrepancy arises from the differing natures of the two assessments. "Dyspnoea" is essentially a personal assessment of exercise tolerance, a functional test, while lung function tests are a static assessment. A major factor in the discrepancy is the localised nature of the pulmonary fibrosis which may follow pulmonary injury and which becomes important only when the respiratory system is stressed. Braun *et al*[14] reported a mild to moderate maldistribution of ventilation in 35% of their survivors of chest injury, suggesting that regional differences in lung function may be important.

Over one half of the survivors of blunt chest injury have some respiratory sequelae as judged by increased respiratory symptoms. The sequelae are more common in smokers and appear as a worsening of productive cough and wheezing. Further analysis of

the data is being undertaken to determine the influence of injury severity, treatment, and complications on the development of respiratory sequelae.

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References

1 Kirsh MM, Sloan H. *Blunt chest trauma. General principles of management*. Boston: Little Brown and Co, 1977.
2 Davidson IA, Bargh W, Cruickshank AN, Duthie WH. Crush injuries of the chest. A follow-up study of patients treated in an artificial ventilation unit. *Thorax* 1969; **24**:563–7.
3 Sankaran S, Wilson RF. Factors affecting prognosis in patients with flail chest. *J Thorac Cardiovascular Surg* 1970; **60**:402–9.
4 Kummer F, Stacher G, Vagacs H. The respiratory function and clinical condition of patients after severe thoracic trauma. *Unfallheilkunde* 1976; **79**:365–8.
5 Baumann PC, Unseld H, Bühlmann A, Rossier PH. Die Lungenfunktion nach schweren Thoraxverletzungen. *Praxis* 1968; **57**:255–9.
6 McGavin CR, Artvinti M, Naoe M, McHardy GJR. Dyspnoea, disability and distance walked: comparison of estimates of exercise performance in respiratory disease. *Br Med J* 1978; **2**:241–3.
7 Greaves DA, Hawthorne VM, McCartney M, Murdoch RM. The collaborative study on smoking in Scotland. University of Glasgow, 1973.
8 Lee PN. *Statistics of smoking in the United Kingdom*. Seventh edition. London: Tobacco Research Council, 1976.
9 Medical Research Council. Committee on research into chronic bronchitis. *Questionnaire on respiratory symptoms and instructions for its use*. London: Medical Research Council, 1976.
10 Fletcher C, Peto R, Tinker C, Speizer FE. *The natural history of chronic bronchitis and emphysema*. Oxford: Oxford University Press, 1976.
11 Todd GF, Laws JT. *The reliability of statements about smoking habits*. Second edition. London: Tobacco Research Council, 1959.
12 Holland WW, Ashford JR, Colley JRT, Morgan DC, Pearson NJ. A comparison of two respiratory symptoms questionnaires. *Br J Prev Soc Med* 1966; **20**:76–96.
13 Simpson DL, Goodman M, Spector SL, Petty TL. Long-term follow-up and bronchial reactivity testing in survivors of the adult respiratory distress syndrome *Am Rev Respir Dis* 1978; **117**:449–54.
14 Braun U, Munz E, Volgt E, Fassolt A. Respiratory function in the late post traumatic period after chest injury. *Intensive Care Medicine*, 1977; **3**:186–7.

Appendix

Pre- and post-injury respiratory symptoms were elicited using a modified MRC Respiratory Symptoms Questionnaire.

1 Before your accident did you usually cough first thing in the morning in winter?
2 Before your accident did you usually cough during the day or at night in the winter?
If YES to 1 or 2: (If NO go to 4.)
3 Before your accident did you cough like this on most days for as much as three months in the year?
4 Before your accident did you usually bring up any phlegm from your chest first thing in the morning in winter?
5 Before your accident did you usually bring up any phlegm from your chest during the day or at night in winter?
If YES to 4 or 5: (If NO go to 7.)
6 Did you bring up phlegm like this on most days for as much as three months of the year?
7 In the three years before your accident did you have a period of increased cough and phlegm lasting for three weeks or more?
8 Before your accident—
(a) Were you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?
If YES
(b) Were you short of breath walking with other people of your own age on level ground?
If YES
(c) Did you have to stop for breath when walking at your own pace on level ground?
9 Before your accident—
(a) Did your chest ever sound wheezing or whistling?
If YES
(b) Did you get this on most days or nights?

The questions were rephrased and repeated to elicit current symptoms. Copies of the full questionnaire may be obtained from the authors on request.

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Notes