

ABSTRACT: Asthma mortality appeared to increase two-fold in the UK from the mid-1970s to the early 1990s, but there is evidence of inaccuracy in asthma death certification and so a region-wide investigation was undertaken to assess whether this recorded statistical trend might have been partly or wholly artefactual.

A total of 35 respiratory physicians, distributed in panels of three, systematically reviewed the hospital and general practice records of 210 subjects with physician-diagnosed asthma who died in 1991 and 1992. The death certificates indicated that asthma was considered to be the primary cause of death in 103 (group 1), a contributory cause in 70 (group 2) and not relevant in 37 (group 3).

There was agreement within the panels that 43% of the subjects had probably never suffered from asthma. Discordance between the panels and the certifying physicians over the correct death certification category was high for group 1 (45% for those aged <65 yrs, 75% for those aged ≥65 yrs and 64% overall) and group 2 (67%), but much less for group 3 (22%).

This study concludes that asthma death certification provides a markedly inaccurate picture of asthma mortality, particularly in elderly subjects. Thus, it is speculated that if the magnitude of this source of inaccuracy has increased over the last two decades, the apparent recent increase in asthma mortality may be largely artefactual.


Asthma morbidity in England and Wales appears to have increased in recent decades, despite advances in therapy, and this is widely attributed to increasing asthma prevalence. This increase has not, however, been fully reflected by mortality trends, and in children and young adults, there have been no clear changes. In adults aged ≥45 yrs (in whom >85% of current asthma deaths are recorded), mean annual mortality doubled between the mid-1970s and the early 1990s in both sexes [1, 2]. The rate of change and the degree of annual fluctuation increased with age, and the apparent increase was most evident in those aged ≥65 yrs.

The cause of the marked increase in recorded asthma deaths in this age group is uncertain. If correct, it could reflect improved diagnostic recognition, an increase in asthma prevalence, an increase in disease severity or an adverse effect of medication. The 1979 and 1984 changes in international coding practice (International Classification of Diseases (ICD) 9, implementation of rule 3) artificially increased the mortality rate in those aged <45 yrs and >75 yrs, respectively, but this provides insufficient explanation for the observed trends [2–4].

Alternatively, the increase may be largely artefactual. The accuracy of death certification is known to decline with advancing age, and there is concern that recent trends, especially in the elderly, may be attributable to diagnostic transfer [5, 6]. An audit investigation in the period 1980–1989 in one district of the Northern Health Region of England suggested that the majority of certified “asthma deaths” had occurred in elderly smokers who had neither died from asthma nor suffered from it [7]. Other studies have suggested that asthma death certification for the whole population may overestimate the number of true asthma deaths by 13–47%, with the degree of inaccuracy in certification rising in the elderly to 39–80% [8–10].

The recorded asthma mortality rates of 3.94 and 3.64 per 100,000 for the Northern Health Region (population 3.07 million) for the years 1991 and 1992, respectively, closely reflect the national figures for England and Wales of 3.67 and 3.48 (total population 51 million). Therefore, experience within the northern region as a whole is likely to be representative of the national picture. The aim of this study was, consequently, to estimate the magnitude of any inaccuracy in death certification for asthma within this region, and hence, to assess whether the apparent increase in asthma mortality in the elderly could have occurred, at least partly, as a result of diagnostic transfer.

Methods

Subjects

Permission was obtained from 13 of the 16 local Health Authorities for a review of death certificates for the years...
1991–1992. Those that included the word “asthma”, either as the direct cause of death (part 1 of the certificate) or as a contributory cause (part 2 of the certificate), were identified. In addition, a random sample was sought from Regional Health Authority records of patients who had died within these districts over the same period and who had a diagnosis of asthma recorded in their hospital records, but whose death certificate did not mention asthma. Hospital and general practice records were sought for all cases.

We identified 375 relevant death certificates and for 215 of these the full hospital and general practice records were obtained. There was additional information from post mortem examinations for 41 of these cases. The failure to retrieve both hospital and general practice records in 160 cases was not associated with any obvious bias of relevance to death certification with regard to age or sex, although those included were more likely to have died in hospital than the 160 who were not included (69 versus 37%). In 67% of these 160 cases, either the hospital records or the general practice records were available for review, but not both, and so we decided to investigate only those for which there were full records from both sources. As a consequence, an unknown number of cases were excluded because there had been no hospital referrals and hence no hospital records.

Study groups, case batches, and sentinel cases

Of the 215 cases with both hospital and general practice records, the initial 210 were classified into three groups: group 1, asthma certified as the direct cause of death (103 cases, 49%); group 2, asthma certified as a contributory but not direct cause of death (70 cases, 33%); and group 3, asthma not mentioned on death certificate but recorded in hospital records as an active problem (37 cases, 18%). Of these 210 cases, 204 were drawn together into 17 batches of 12, each batch containing at least one case from each death certification group. The six other cases, two from each death certification group, had been selected at random as “sentinel cases” to assess consistency and repeatability among the reviewers. They were distributed in two sets of three cases (one from each certification group). One set was included in all odd numbered batches, and the other in all even numbered batches, so that each reviewed batch of 15 cases contained 12 regular cases for single review and three sentinel cases for multiple review. The remaining five of the 215 cases were insufficient to form a batch and so were not included in the investigation.

Reviewer panels

Each batch of 15 cases was reviewed by a panel of three respiratory physicians, two trained consultants and a registrar trainee. New panels were constituted as each case batch was prepared, so that the task was shared as evenly as possible. All regional consultants and trainee registrars were invited to participate and almost all did so, i.e., 23 consultants and 12 registrars, each reviewing one to three (usually two) batches of cases. Each physician reviewed the data independently without seeing the death certificates, and without knowledge of the distribution of cases by certification group or sentinel status. It was known, however, that all three death certification groups would be represented.

A standardized questionnaire was used to aid the physicians summarize their reviews of the hospital and general practice records. They were then asked to conclude whether: the subject had asthma, asthma directly caused death or asthma contributed to death if it was not the direct cause; they were also asked to identify the level of probability associated with each conclusion: most unlikely, i.e., <10; probably not, i.e., 10–29%; conceivably but unlikely, i.e., 30–49%; more likely than not, i.e., 50–69%; probably, i.e., 70–89%; or almost certainly, i.e., >90%. They were also invited to identify any other disorder that they considered was the direct or a contributory cause of death.

Analytical methods

The primary method of analysis, leading to a “consensus” conclusion, was based on the categorical result from each reviewer, i.e., was the answer to a given question probably yes (≥50% probability) or probably no (<50% probability)? The agreement of at least two of the three reviewers was required for each nonsentinel case, and a majority of at least two thirds among the many reviewers for each sentinel case. As an alternative method of analysis, the mid-points within each probability range (i.e., 5, 20, 40, 60, 80, 95%) were used to obtain a score from each reviewer, thereby taking account of the reviewer’s individual levels of confidence. Providing that at least two panel physicians were able to offer a score, the panel conclusion for each question was then expressed by the “mean panel score”. A mean score ≥50% indicated a positive (yes) answer to the question posed.

Results

Demographic data

Of the 210 cases, 91 were males and 119 were females. Of the males, 35 (38%) were aged <65 years, and 56 (62%) ≥65 yrs. Of the females, 33 (28%) were aged <65 yrs, and 86 (72%) ≥65 yrs.

Asthma diagnosis

The panels agreed by consensus with the diagnosis of asthma in 120 (57%) of the 210 cases (unanimously in 78, by majority in 42), and disagreed in 89 (unanimously in 52, by majority in 37). In one case, there was insufficient information to permit a consensus conclusion, two reviewers disagreeing with each other and one abstaining because the data were considered inadequate. The percentage of subjects thought to have had asthma was similar in all death certification groups: group 1, 55%; group 2, 57%; and group 3, 59%. However, the percentages differed significantly between those aged <65 yrs and those who were older (70 versus 50% respectively; \( \chi^2 = 5.986; p<0.05 \)).

Asthma mortality

The reviewing panels were able to reach a conclusion about the cause of death in 191 of the 210 cases (unanimously in 61% and by majority in 39%). Their conclusions, by the consensus method, are shown in table 1.
panels agreed with the certifying physicians that asthma was the direct cause of death in only 31 of the 86 (36%) cases so certified in group 1, and that it was of some relevance (i.e. direct or contributory cause) in only 50 of the 153 (33%) cases in which the word "asthma" appeared on the death certificate (groups 1 and 2 combined). They agreed with the certifying physician that asthma was not relevant to death in 29 of the 37 (78%) group 3 cases.

There was a high level of agreement among the reviewing physicians over the relevance of asthma to death in the six randomly chosen sentinel cases (table 2). Agreement was almost unanimous (>95%) in five of the six cases and by a clear majority (70%) in the other. Despite this, there was agreement between the panels and the certifying physicians in only half of these cases.

Five panel physicians unknowingly reviewed a set of three sentinel cases twice, thereby providing 15 duplicated reviews. Identical results were obtained for all but two of the 15 pairs. One reviewer considered that asthma was not relevant to death initially, but decided that there was insufficient information to judge when the case was reviewed the second time. Another initially considered asthma to be a contributory cause of death, but the direct cause at the second review.

Almost all of the group 3 subjects had died in hospital (this had no doubt helped the Health Authority to identify them), but the sites of death (hospital or community) of the group 1 and 2 subjects were distributed much more evenly. The independent importance of place of death and age to the likelihood of discordance between panels and certifying physicians was assessed using logistic regression analysis. Discordance over the cause of death in the group 1 cases was significantly more likely with increasing age (75% for those aged 65 yrs versus 45% for those aged <65 yrs, the odds of disagreement increasing by 3.6% per year of age difference; p=0.028) and there was more discordance over the group 1 and 2 cases together than over the group 3 cases (67% versus 22%, odds ratio=11.7; p<0.001). Whether death occurred in the community or hospital (i.e. whether the certifying physician was a general practitioner or junior hospital doctor) exerted no influence (odds ratio=1.12; p=0.8). The internal disagreement between panel physicians was also greater for the group 1 and 2 cases than for the group 3 cases (p<0.001, one-way analysis of variance (ANOVA)), but the age at death did not exert any influence on their ability to reach a conclusion or on the level of internal disagreement.

Mean panel scores

The supplementary analysis using the mean panel scores gave almost identical results to those obtained categorically by consensus. Of 209 cases for which both methods could be used to assess the diagnosis of asthma, only eight gave a positive outcome for one but a negative outcome for the other. For 191 cases, at least two panel physicians were able to offer a score for the cause of death (table 3), and for 190 of these, the results could be compared with the results of the consensus method of assessment. Inconsistencies were noted in only three, all from group 3. In one, asthma was considered a “contributory” cause of death by consensus but “not relevant” by mean score, and in another the converse occurred. In the third case, asthma was considered a “contributory” cause by consensus but the “direct” cause by mean score.

Cause of death identified by panels

In the 55 group 1 cases where the panels disagreed with the certifying physician that asthma was the direct cause

Table 1. – Conclusions by consensus on relevance of asthma to death, by certification group

<table>
<thead>
<tr>
<th>Panel conclusion</th>
<th>Death certification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1 direct</td>
</tr>
<tr>
<td>All subjects</td>
<td>86</td>
</tr>
<tr>
<td>Direct</td>
<td>31</td>
</tr>
<tr>
<td>Contributory</td>
<td>17</td>
</tr>
<tr>
<td>Not relevant</td>
<td>42</td>
</tr>
<tr>
<td>Subjects aged &lt;65 yrs</td>
<td>31</td>
</tr>
<tr>
<td>Direct</td>
<td>17</td>
</tr>
<tr>
<td>Contributory</td>
<td>5</td>
</tr>
<tr>
<td>Not relevant</td>
<td>13</td>
</tr>
<tr>
<td>Subjects aged ≥65 yrs</td>
<td>55</td>
</tr>
<tr>
<td>Direct</td>
<td>14</td>
</tr>
<tr>
<td>Contributory</td>
<td>8</td>
</tr>
<tr>
<td>Not relevant</td>
<td>33</td>
</tr>
</tbody>
</table>

Values are numbers of cases.

Table 2. – Sentinel cases: number of respiratory physicians recording the relevance of asthma to death in each possible diagnostic category, by certification group

<table>
<thead>
<tr>
<th>Physicians’ conclusions</th>
<th>Death certification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1 direct</td>
</tr>
<tr>
<td>Odd batches</td>
<td>Case O1</td>
</tr>
<tr>
<td>Direct cause</td>
<td>24</td>
</tr>
<tr>
<td>Contributory</td>
<td>0</td>
</tr>
<tr>
<td>Not relevant</td>
<td>0</td>
</tr>
<tr>
<td>Even batches</td>
<td>Case E1</td>
</tr>
<tr>
<td>Direct cause</td>
<td>1</td>
</tr>
<tr>
<td>Contributory</td>
<td>0</td>
</tr>
<tr>
<td>Not relevant</td>
<td>23</td>
</tr>
</tbody>
</table>

For odd batches, there were 27 reviews and for even batches, 24. In some cases, the individual reviewer did not consider that there was sufficient evidence to offer an opinion.

Table 3. – Conclusions by mean score on relevance of asthma to death, by certification group

<table>
<thead>
<tr>
<th>Panel conclusion</th>
<th>Death certification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1 direct</td>
</tr>
<tr>
<td>All subjects</td>
<td>87</td>
</tr>
<tr>
<td>Direct</td>
<td>31</td>
</tr>
<tr>
<td>Contributory</td>
<td>13</td>
</tr>
<tr>
<td>Not relevant</td>
<td>43</td>
</tr>
<tr>
<td>Subjects aged &lt;65 yrs</td>
<td>31</td>
</tr>
<tr>
<td>Direct</td>
<td>17</td>
</tr>
<tr>
<td>Contributory</td>
<td>5</td>
</tr>
<tr>
<td>Not relevant</td>
<td>9</td>
</tr>
<tr>
<td>Subjects aged ≥65 yrs</td>
<td>56</td>
</tr>
<tr>
<td>Direct</td>
<td>14</td>
</tr>
<tr>
<td>Contributory</td>
<td>8</td>
</tr>
<tr>
<td>Not relevant</td>
<td>34</td>
</tr>
</tbody>
</table>

Values are numbers of cases.
of death, the true cause was thought to be smoking-rela-
ted chronic obstructive pulmonary disease (COPD) in 28
(51%), both COPD and cardiovascular disease in six
(11%), cardiovascular disease alone in six (11%), an alter-
native respiratory disorder in three (sarcoidosis 2%, pul-
monary embolism 4%) and a variety of other diseases in
10 (18%). In two cases, the panels were unable to identify
the probable direct cause of death, although in one, asthma probably contributed.

Discussion

It is well recognized that death certificates may be inac-
curate, the degree of inaccuracy being greatest in the eld-
erly, for whom there are often multiple pathologies and
a natural reluctance to obtain a necroscopic diagnosis.
Despite this, mortality trends derived from asthma death
certifications have exerted a considerable influence during
recent decades, and the apparent steady rise in older age
groups has led to fears that treatment may be ineffective or
may have unsuspected dangers [11–14].

Our investigation suggests that inaccuracies in attribut-
ing death to asthma are likely to be substantial, although
it should be recognized that the physicians certifying death
may have possessed additional information of relevance to
that available to the reviewing panels. Differences in opin-
ion between certifying physicians and panel physicians do
not necessarily mean, therefore, that the errors lay with
the former rather than the latter. Furthermore, approxima-
tely one third of the panels' conclusions were reached by
majority, not unanimous, verdict, and by corresponding
mean scores in the most uncertain probability range, i.e.
30–69%. This implies that diagnosing asthma and assess-
ing its relevance to death are often difficult tasks, although
the panel physicians did not appear to find this more diffi-
cult in the older subjects, despite the frequency of other
orders of possible relevance. We consequently assess-
ed the overall concordance between panels and certifying
physicians by considering whether asthma was likely to
have been relevant to death (i.e. direct or contributory case),
since this would minimize differences of opinion over
quantitative issues, while still allowing an assessment of
the fundamental qualitative issues.

In fact, the levels of concordance were of a similar or-
er, whether asthma was assessed specifically as the di-
rect cause of death (i.e. group 1 cases only) or more widely
as a factor of relevance (i.e. groups 1 and 2 combined).
Thus, concordance proved to be poor for group 1 and 2
cases where asthma was certified to be relevant, but good
for group 3 cases where the death certificates did not men-
tion asthma. Although panel conclusions were not always
clear cut, the six randomly selected sentinel cases usefully
indicated that the panel physicians as a group showed a
high level of consistency in assessing the cause of death,
as did the five individual panel physicians who provided
duplicate reviews. This was despite the poor level of con-
cordance (merely 50%) between the panels and the certi-
fyng physicians for these sentinel cases. There was also a
high level of consistency between the consensus conclu-
sions of the panel physicians and their conclusions de-
ved from mean probability scores. This suggests that the
results did fairly reflect the considered opinions of practis-
ing respiratory physicians rather than the method of ana-
lysis. Almost every respiratory physician in the region
contributed to the investigation and no one physician con-
tributed to excess. Furthermore, all three possible death
certification groupings were known to be represented in
each batch of cases, although in unknown proportions. It
is doubtful, therefore, whether any important systematic
biases were operating, and we think it is likely that the
findings do indicate a substantial "false positive" inaccu-
ray in asthma death certification.

The discordance between panel physicians and certifying
physicians in assessing the direct cause of death in the
group 1 cases was much greater (and significantly so) in
the older subjects, being 75% in those aged >65 yrs but
45% for the remainder. However, internal disagreement
within panels was not related to age (or place of death).
This suggests that the increasing discordance between
panels and certifying physicians with increasing age was a
consequence of differences in diagnostic opinion rather
than a lack of information.

The effect of patient age on agreement about the cause
of death is important as most certified deaths from asthma
(abut 60%) occur in this older population, and national
statistics are unduly weighted by them. If the false positive
certification rate was of the order of 75% nationally in
this older population in the early 1990s, there would have
been 800–900 false positive certifications annually in
England and Wales, enough to account for the apparent
overall increase in asthma mortality since the mid-1970s.
The recent trend in this older group may consequent-
ly have been entirely artefactual. For this to be so, there
would have been about 300 true asthma deaths among
the total of 1,100–1,200 certified in the early 1990s in sub-
jects aged >65 yrs, and also about 300 among the total of
500–600 certified annually in the mid-1970s. This would
imply an increase in the false positive rate of asthma death
certifications from about 50% (approximately the rate that
we have found in 1991–1992 for subjects aged <65 yrs) to
75%, which seems plausible though is entirely specula-
tive. It would imply, in addition, that if asthma prevalence
has increased without any increase in overall mortality, the
risk of death in an affected individual must have de-
creased. Recently developed management strategies may,
therefore, have been more successful than has been sug-
gested.

Diagnostic transfer from COPD appeared to be respon-
sible for many of the false positive asthma death certifica-
tions, a phenomenon noted in other studies [5, 6, 10, 15].
There is an increasing tendency to treat patients suffering
from fixed airflow obstruction (which may occasionally
be a consequence of long-standing asthma) with the same
medications that are used for asthma, and as such patients
may perceive some benefit from this treatment, it may be
that the diagnostic terms COPD and asthma have come to
be used interchangeably, at least in some subjects. This is
especially likely in patients who are not referred to res-
piratory medicine clinics and who do not, consequently,
dergo adequate diagnostic tests of lung function. During
the era in which there has been increasing awareness of
asthma by public and physicians alike, it may have be-
come the preferred diagnosis and so have appeared subse-
quently, though erroneously, on death certificates. For
the particular population in the present study, the panels
concluded that there was insufficient evidence from either the
general practice records or the hospital records to sustain a
diagnosis of asthma in a substantial proportion (42%). Again, this percentage was significantly greater in subjects aged 65 yrs (50%) than in those who were younger (30%).

The investigation was aimed primarily at assessing the accuracy of group 1 and 2 death certifications, i.e., an assessment of false positive inaccuracy. The group 3 cases were included to lessen the possibility of bias during the reviewing process. Reviewers might have been prejudiced by suspecting that asthma mortality had been exaggerated or underestimated. However, they would have known that any individual case could have come from any one of the possible death certification groups, and that other reviewers would also assess each case. The number of group 3 cases was insufficient for a meaningful assessment of false negative inaccuracy in asthma death certification, and they were not selected from any particular death certification grouping. We cannot estimate, therefore, how many true asthma deaths are hidden among the statistics relating to death from COPD, cardiovascular disease, or any other causes. We noted, nevertheless, that of the 37 group 3 cases, the panels concluded that asthma was the direct cause of death in four and a contributory cause in a further four. By coincidence, a very recent investigation of asthma mortality in the 16–64 yr age group suggested that false negative certifications had occurred in four of 22 cases (18%; 95% confidence interval 5–40) [16].

In view of the high prevalence of asthma within the population at large and the large number of deaths attributed to COPD (or to alternative diagnostic terms) and cardiovascular disease, the cumulative potential for false negative certification of asthma deaths is formidable. Underestimation of asthma mortality through this phenomenon is, consequently, all too likely to counteract, to some degree, the probable error towards overestimation that we have identified in this investigation. Unrecognized asthma deaths are not, however, likely to invalidate our suggestion that recent trends of increasing asthma mortality in the elderly may be, primarily, a consequence of artefact (increased "false positive" certification) because it is improbable that there would have been increases in diagnostic transfer in opposite direction simultaneously.

We conclude that recent statistics of asthma mortality are seriously flawed by false positive certification. This results from diagnostic transfer from other diseases, principally chronic obstructive pulmonary disease, but it is not closely related to whether death occurs in hospital or in the community, and so to whether the death certificate is completed by junior hospital doctors or general practitioners. We speculate that recent trends suggesting an increasing risk of death from asthma in older age groups are partly (or even wholly) artefactual and that, if asthma prevalence is actually increasing, recently developed management strategies (and current medications) have been more successful than has been suggested.

References

5. Whallet E, Ayres J. Labelling shift from acute bronchitis may be contributing to the recent rise in asthma mortality in the 5–34 age group. Respir Med 1993; 87: 183–186.