The Online Cough Clinic – Developing Guideline-Based Diagnosis and Advice

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Short Title:
The Online Cough Clinic

ABSTRACT

Objective To make the chronic cough guidelines more practical and user friendly by developing an internet-based interactive diagnostic questionnaire for chronic cough.

Methods Prospective cohort study of chronic cough sufferers in the UK following European Respiratory Society guidelines for the diagnosis and management of chronic cough. Depending on the response to 16 specific questions the medical condition responsible for the patient's chronic cough was ascertained according to a predetermined diagnostic algorithm designed to differentiate the three common causes of chronic cough. Appropriate advice and treatment recommendations, were then provided.

Results 8546 adults with chronic cough completed the *Cough Clinic* diagnostic questionnaire. 46.1% were suggested to have reflux, 38.7% asthma and 15.2% rhinitis. Participants found the web-site easy to use (94%), the advice helpful (73%), helped them to communicate with their GP better (60%) and 62% reported taking the recommended treatment.

Conclusion The *Cough Clinic*, an internet-based diagnostic site for chronic cough, had a large uptake by chronic cough sufferers in the UK. Almost half were diagnosed as having reflux as the probable cause of their chronic cough. Internet diagnosis by expert algorithm provides a novel mechanism for patients to access guideline recommended therapies and enhances dialogue between patients and physicians.

Keywords:
chronic cough, diagnosis, gastro-oesophageal reflux, questionnaire

INTRODUCTION

The challenge of making an accurate diagnosis remains one of the most fulfilling roles of physicians[1]. Clinical practice guidelines are considered as important tools to guide evidence-based decision making[2]. However, the routine practice of guidelines, many of which can be of hundreds of pages, has been reported to be low[3]. Doctors and patients are becoming more proficient in using the internet with 31.8 million adults in the UK estimated to have internet access (15.2 million households) with searching for health information at the top of the list of reasons for using the web[4]. Google$^®$ searchers can find the correct diagnosis for their medical condition in 58% of cases[5]. Hence, the hypothesis is that a guideline–based web clinic would be a practical way to address patients' healthcare queries.

Chronic cough is defined as a cough lasting for greater than eight weeks and is a disabling symptom with a significant impact on a patient's quality of life. Cough is the commonest symptom for which medical care is sought[6]. In the absence of any obvious respiratory disease, three common causes have been proposed for chronic cough; reflux disease, an asthma syndrome, and rhinitis. The European Respiratory Society (ERS) guidelines illustrate the development of the approaches to cough[7, 8].

The *Cough Clinic* (www.coughclinic.org.uk) is an internet-based diagnostic site developed to suggest a probable diagnosis of the condition causing a patient's chronic cough. The *Cough Clinic* individualises advice based upon the guidelines set by the ERS [7] thus making the guidelines more practical, while at the same time providing information about the condition for both patients and their physicians.

The diagnosis of the aetiology of cough in a patient requires relevant information from the patient's medical history followed by the assigning of weighting factors to the information to predict the most likely diagnosis. Correct diagnosis is crucial for an effective therapy. An online internet-based system which claims to be able to give an accurate diagnosis, should be able to perform all of the above functions.

Here we describe the *Cough Clinic* website and its role in diagnosis of chronic cough and patient appreciation of the pathway.

METHODS

Data collection

On entering the *Cough Clinic* site the patient was registered, provided consent and demographic data was collected (age, gender, region of living). Before proceeding with the questionnaire, the patient was required to confirm that a normal chest X-ray had been obtained, as it is mandatory for the investigation of chronic cough.

The questionnaire is set over 3 pages. The patient is asked about the length of time that they have suffered with cough with a Likert scale (0-10) used to score the severity of the cough. The patient is asked to answer a series of questions to determine other relevant factors. The second page gathers further information on the patient's smoking habit and medication use. The third page asks about key diagnostic symptoms and their severity by Likert scale (0-5) (table 1). For diagnosis of reflux induced cough these questions are based on the validated Reflux Symptom Index (RSI) [9] and the Hull Reflux Cough Questionnaire (HRCQ). Asthma symptoms were based on Royal College of Physicians questionnaire[10].

Certain symptoms (e.g. haemeoptysis) were identified as 'red flag' symptoms and the completion of the questionnaire was terminated with advice to obtain specialist help. Red flag symptoms were only seen in 8 patients (3 coughing up blood and 5 coughing up more than one cupful of phlegm).

Algorithm & diagnosis

An algorithm was applied to the questionnaire responses after assigning weighting factors to calculate as a percentage of the maximum probability of the three main causes of chronic cough. The condition with the highest percentage was chosen as the most probable diagnosis (reflux, asthma or rhinitis) causing the chronic cough. The algorithm was scored as a percentage of the total possible score for each symptom. Thus although there were more questions pertaining to reflux the algorithm was not biased towards a reflux diagnosis since each individual question contributed a smaller percentage to the total.

Treatment

When the diagnosis is made the ERS guidelines recommend a therapeutic trial of the most appropriate treatment. The *Cough Clinic* generates a generic letter for the patient to take to their Primary Care Physician which refers to the completed questionnaire, the ERS guidelines and the suggested diagnosis of the cause of the patient's chronic cough, it also suggests the most suitable treatment trial for the patient. (appendix)

Follow up

As for any other medical consultation, the clinician needs to assess the effectiveness of the diagnosis and the recommended treatment. After two months the patient receives a request to complete a follow-up questionnaire over the internet. This allowed for the assessment of the patient's current symptoms, current medications, patient compliance and the efficacy of the recommended treatment. We also inquired into the patient satisfaction with the *Cough Clinic*.

RESULTS

Demographics

Between the time the site went live (January 2006) and October 2007, 13610 people had registered for the site of which 8546 patients (63%) in the UK completed the *Cough Clinic* online cough diagnosis questionnaire. There was a female dominance (57%) and the mean (SD) age was 45.5 (16.4) years with ages ranging from 18-86 (fig 1).

The duration of cough, for all of the responders, was more than 3 months and in 64.8% of patients was less than a year, 13.7% of patients had had their cough for more than 5 years.

Patients were asked to score the severity of their cough on a Likert scale of 0-10 (10 being the most severe and frequent cough) and the mean (SD) score for cough among the patients was 5.85 (2.1).

The mean (SD) cough score varied depending on their suggested diagnosis ($p < 0.0001$ one-way ANOVA) with those patients diagnosed with reflux scoring 5.4 (2.2), those diagnosed with rhinitis scoring 5.8 (2.08) and those diagnosed with asthma scoring 6.4 (2.15).

41.4% of patients were either current smokers or had previously been smokers. 11% of responders had previous diagnosis of respiratory illnesses; such as COPD, bronchiectasis, emphysema and asthma, with asthma the greatest (9% of all).

From the drug history, 21.6% of patients were on inhalers, of which 11% were steroid inhalers. 19% took blood pressure tablets with 7% on angiotensin converting enzyme (ACE) inhibitors. ACE inhibitors known side effects include chronic cough which occurs at the rate of approximately 15%, depending on the population studied[11].

Specific questions to aid diagnosis

There were sixteen questions that were used to specifically ascertain the medical condition responsible for the patient's chronic cough (table 1). Each question was scored for severity using a Likert scale of 0-5.

Depending on the score given for each question a weighting was applied relevant to the importance of that symptom for the three common causes of chronic cough.

Table 1: Questions used to ascertain the probable medical condition responsible for a patient's chronic cough.
The questions were asked in a random order and not as listed.

Number	Question	Weighting
1	Cough with eating (during or straight after meals)	reflux
2	Cough with certain foods	reflux
3	Cough when you get out of bed in the morning	reflux
4	Cough brought on by singing or speaking (for example, on the telephone)	reflux
5	Hoarseness or a problem with your voice	reflux
6	Clearing your throat	reflux
7	Cough after lying down	reflux
8	Heartburn, chest pain, indigestion or stomach acid coming up	reflux
9	Wheezing or chest tightness in general	asthma
10	Cough waking you from sleep	asthma
11	Shortness of breath when not coughing	asthma
12	Blocked or stuffy nose	rhinitis
13	Excess mucus in the throat, or drip down the back of the nose	rhinitis
14	Itchy nose and/or sneezing	rhinitis
15	Loss of the sense of smell	rhinitis
16	A feeling that mucus is running down the back of your throat	rhinitis

The breakdown of any symptoms reported (score 1-5) by the population group studied is shown in figure 2 and it was possible to identify differences between the groups. There was a clear distinction in the type of symptoms reported by those diagnosed with probable asthma and those diagnosed with probable rhinitis. Focusing on the moderate to severe symptoms (3-5), which had the weighting factors applied to them, shows that each predicted diagnosis presents with a different profile (fig 3). Those with probable rhinitis responded highly to questions 12-16, those with probable asthma responded to questions 9-11 whereas those with probable reflux were those that did not respond high to questions 9-16 but had a high proportion of symptoms related to questions 1-8.

Coughing after lying down was reported to be the most severe accompanying symptom (20% scored it as 5 and 18.5% as 4) while hoarseness was the mildest accompanying symptom (15.8% scored it as 1 and 17.4% as 2). Clearing the throat in probable reflux patients, coughing after lying down in probable asthmatic patients, and post nasal drip in probable rhinitis were the most troublesome symptoms in the different groups.

Validation study

The *Cough Clinic* algorithm was tested in a pilot study of 30 patients attending the Hull cough clinic. Patients were administered the questionnaire before being seen as new patients by the medical team. There was a close association

between the web-based *Cough Clinic* diagnosis and that of the clinician's full work up. Only two patients did not have agreement in diagnosis between the two methods. We recognize that there is insufficient power to provide an accurate estimate of diagnostic accuracy but took the view that there would be variation between different clinicians similar, if not greater than, that between the algorithm.

Final diagnosis

Three probable diagnoses, reflux, asthma and rhinitis were the main outcomes of the questionnaire; 3936 [95% CI 3846-4027] (46.1%) of patients were diagnosed with reflux, 3310 [95% CI 3222-3398] (38.7%) diagnosed with asthma and 1300 [95% CI 1173-1427] (15.2%) were diagnosed as having rhinitis (fig 4).

Follow-up questionaire

A request to complete a follow-up questionnaire two months after the initial suggested diagnosis was sent to 8434 patients. Response was only given by 1047 (12.4%). Of the patients completing the follow-up questionnaire 94% said they found the site easy to use, 73% found the advice helpful while 60% stated that it helped them communicate with their GP better. 62% of patients had taken a recommended treatment.

DISCUSSION

Guidelines and approved evidence-based clinical algorithms, are vast swathes of information, which are hard to be memorised and put into practice. The use of online tools to put guidelines into practice and provide quality information to patients is a valuable addition to the healthcare armoury. The use of the *Cough Clinic*, an internet-based diagnostic site to diagnose the condition causing a patient's chronic cough was assessed in the current study.

It should be stressed that definite diagnosis cannot be obtained using this internet-based approach without full investigative work-up. The suggested diagnosis is provided with appropriate advice and treatment but further medical consultation is advocated, with a computer-generated letter provided. However, it is more likely to propose a diagnosis unlikely to have been put forward by the GP in an initial consultation. Our previous experience indicates that in chronic cough patients seeking a consultation the overwhelming majority have seen at least one and often two doctors [13].

There has been large utilisation of the *Cough Clinic* site by adult chronic cough sufferers in the UK covering a wide demography with the majority suffering from cough for three months to one year. The 16 part symptom questionnaire and associated algorithm was the main diagnostic device to determine if reflux, rhinitis or asthma was the probable cause of the chronic cough. The questions were derived from studies characterising the symptom complex associated with each condition. In reflux our previously determined symptom profile of patients with pH proven acid reflux and chronic cough was utilised[14]. For asthma the Royal College of Physician questionnaire was used [10]. For rhinitis questions from the rhinosinusitis specific Sino-Nasal Assessment Questionnaire was used[15]. It should be noted that although the three questionnaire components of the *Cough Clinic* are validated the whole questionnaire and algorithm is not. There were three distinct patterns of response to the 16 questions. A high score to questions 9-11 pointed to asthma, high scores in questions 12-16 indicated rhinitis while consistently moderate to high scores to questions 1-8 signified reflux.

The population of chronic cough sufferers completing the *Cough Clinic* is the largest cohort studied to date by an order of magnitude. Previously published epidemiological studies of chronic cough have used cohorts ranging from 43-228 patients due to the specialist nature of the condition and prevalence data of the three main causes of chronic cough varies widely[16-28]. The prevalence of asthma ranged from 6-59%, GORD 0-41% and rhinitis 8-56%. We amalgamated the data from these thirteen studies and the overall number of patients was 1258 with 25% with asthma, 20% with GORD and 34% with rhinitis[8].

In the study presented here the prevalence of probable GORD was 46.1% and higher than previously seen indicating that those presenting to secondary care may be the tip of the iceberg and the condition may be more common than

previously believed. Probable asthma was responsible for chronic cough in 38.7% of our study group population which is in the range previously seen. Probable rhinitis was less prevalent in chronic cough sufferers than previously found (15.2%). Our population is significantly different from those previously reported in the literature in that we have not excluded patients with significant airflow limitation. It is possible that other diagnoses such as COPD may be responsible for cough in a proportion of the patients reported here, however, it is also possible that patients with airflow obstruction may have one of the underlying causes of cough discussed above. This is one of the unavoidable limitations of an internet-based algorithm.

The study has given us an interesting insight into the likely aetiology of chronic cough in this biased segment of the general population (internet users seeking medical advice online). In addition, it is our intention to follow-up the patients who have received an initial diagnosis for their chronic cough with a second internet-based questionnaire. This follow-up questionnaire will be used to obtain information on treatment efficacy and will enable us to carry out internet-based clinical trials as well as epidemiological and market research studies. However, to date follow-up response has been low (12.4%) and thus data gathered to date has not been presented here.

Although the current study was based only on chronic cough sufferers in the UK (with internet access) it is our intention to extend the internet-based questionnaire to other countries where guidelines are available. This will make it possible to better study the aetiology and the epidemiology of chronic cough across countries and populations.

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Figure Legends

Fig 1 Breakdown of ages of the population completing the questionnaire. There was no specific dominant age group.
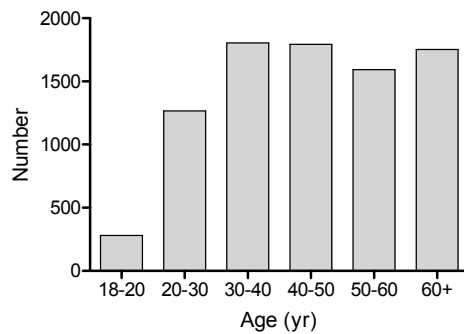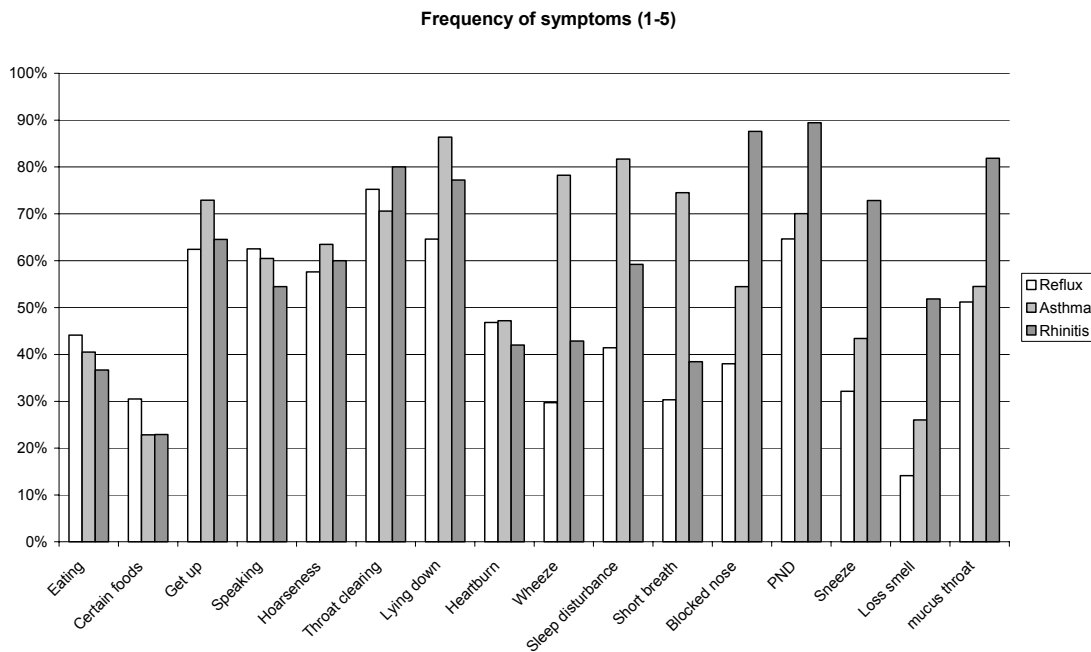
Fig 2 Percent of patient's reporting the presence of symptoms from questions 1-16 (score 1-5).

Fig 3 Percent of patient's reporting the presence of symptoms from questions 1-16 (score 3-5).
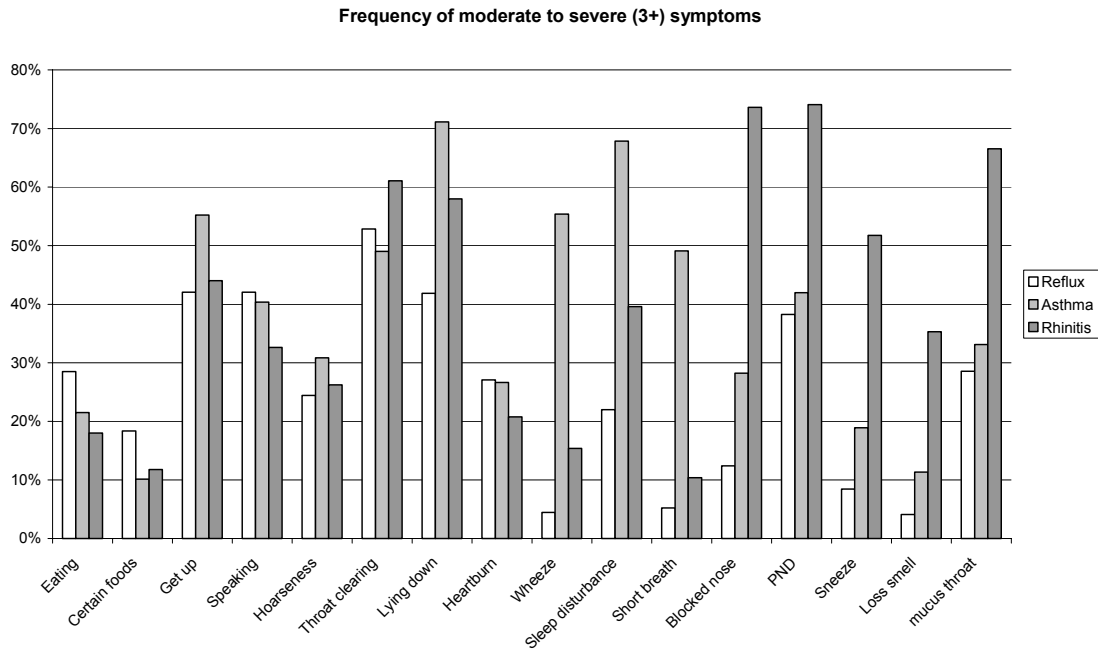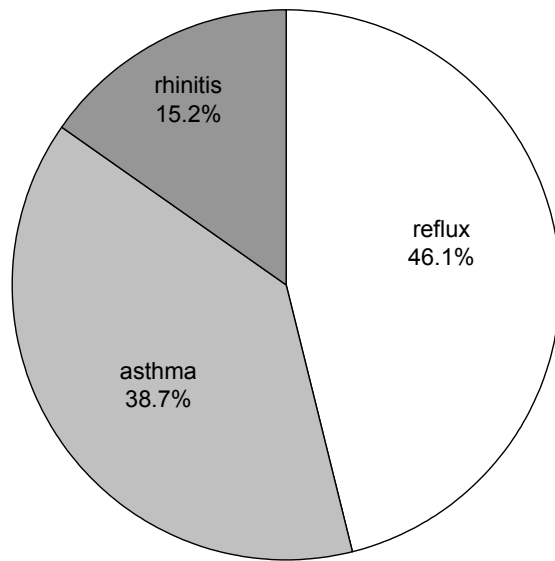
Frequency of moderate to severe (3+) symptoms

Fig 4   Probable diagnosis of medical condition responsible for chronic cough in 8546 patients completing the *Cough Clinic* questionnaire.

Competing Interests
PWD and AHM are directors of Selfnostics Ltd, which hold the rights to *Cough Clinic*.
All other authors have nothing to declare.

Ethical Approval
Ethical approval for the study was granted by Hull and East Riding local research ethics committee (LREC). R&D approval was granted by Hull NHS Trust.
All patients provided online consent at the time of completion of the *Cough Clinic* questionnaire.

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No funding was required for this study and so there are no conflicts of interest to report.