Early warning and NHS Direct: a role in community surveillance?

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Abstract

Background NHS Direct is a nurse-led telephone helpline that covers the whole of England and Wales. NHS Direct derived data are being used for community surveillance, the purpose of which is to detect a local or national increase in symptoms reported by callers. The system has the potential to identify an increase in symptoms reported by callers about people in the prodromal stages of illness caused by the deliberate release of a biological or chemical agent. There are no other community surveillance projects existing on a national scale that utilize electronic daily data.

Methods We describe the surveillance system and calls to NHS Direct between December 2001 and July 2002. Confidence limits have been constructed for 10 key algorithms at each site and control charts devised for five of these algorithms at sites covering the key urban areas.

Results Daily reporting has been achieved from NHS Direct sites in England and Wales. High levels of activity in specific algorithms at both national and regional levels have been detected. A sustained national increase in calls about fever occurred in January 2002.

Conclusion Although the project is still at an early stage, daily analysis of NHS Direct data has the potential to detect symptoms in the community that could be related to deliberate releases of chemical or biological agents or to outbreaks of disease. For this surveillance to act as an ‘early warning’ of illness resulting from a microbiological or chemical cause, the NHS Direct surveillance needs to be fully integrated into an appropriate public health response (which may require diagnostic samples to be taken from callers).

Keywords: NHS Direct, surveillance, fever, bioterrorism

Introduction

According to the Chief Medical Officer, ‘Good surveillance is the cornerstone of a system to control infectious diseases in the population’. Currently, the United Kingdom has a variety of communicable disease surveillance systems, including clinical reporting, data from laboratories and data from specific surveys. Recently, it has also become possible to use NHS Direct call data to add to existing methods of community surveillance (and in the last few years a scheme for ‘influenza-like illness’ surveillance has been developed, based on monitoring NHS Direct data).
anthrax in the United States in autumn 2001, together with heightened fears over the possibility of biological terrorism, led to the establishment of a joint project between the Public Health Laboratory Service–Communicable Disease Surveillance Centre (PHLS–CDSC) and NHS Direct. The aim of the project was to detect local or national increases in symptoms likely to be reported by callers about people in the prodromal stages of illness caused by the deliberate release of a biological or chemical agent. In monitoring these data, we also hoped to be able to detect community outbreaks of more common infectious diseases.

**Methods**

**Description of symptoms monitored**

We wanted to be able to detect a rise in symptoms of the sort that would be present in the early stages of disease caused by biological or chemical weapons. With the probable exception of diplopia (which could be a symptom of the onset of botulism), these are generally symptoms of a non-specific nature. The algorithms we monitor are as follows:

- Cold/flu
- Cough
- Vomiting
- Food poisoning
- Rash
- Fever
- Difficulty breathing
- Diarrhoea
- Double vision
- Lumps

The daily data obtained from each NHS Direct site form a report in two parts. The first part of the report (‘part 1’) contains the number of times an algorithm has been used and the dispositions for that algorithm. On weekdays and bank holidays this first part is sent electronically to the Health Intelligence Unit (HIU) of NHS Direct, where data are collated and sent to CDSC for analysis. The second part of the report (‘part 2’) contains a more detailed call listing including the call identifying number, postcode and the age of the person about whom the call was made. This second part of the report is kept at the NHS Direct site and only accessed by the project team on request.

**Statistical analyses**

Upper confidence limits (99.5 per cent level) of algorithm calls, as a proportion of daily total calls, were constructed for each of the 10 key algorithms at each site, based on historical data from 18 December 2001. In addition to this analysis, a more sophisticated model (using control charts) was constructed for five of the 10 key algorithms at the sites covering the major urban centres (London, Manchester, Leeds–Bradford, Birmingham and Newcastle). The charts were constructed by assuming the number of algorithm calls follow a Poisson distribution with total number of calls as an offset. A model was fitted to each site separately, always containing a bank holiday term (bank holiday or not) and, if needed, a day factor (weekday, Saturday or Sunday) and a linear time trend term. Scaling was performed to account for over-dispersion when this was present. The upper 99.5 per cent limit was then derived from the fitted model and scale parameter.

**Response to an increase in calls**

When calls for an individual algorithm exceeded the 99.5 per cent upper confidence interval or control chart upper prediction limit (99.5 per cent), this was termed an ‘exceedance’. All exceedances were checked by the project scientist, starting the process for investigation (termed ‘Sc’). First, the accuracy of the data was checked. Next the level of activity at neighbouring sites; previous exceedances; the degree to which the reading exceeded the upper prediction level; current community levels of disease; and the severity of call dispositions (e.g. ‘home care’ or ‘advised to visit an Accident and Emergency Department’) were noted. Unless this provided a reasonable data-related explanation for the exceedance, the scientist discussed this with a project consultant epidemiologist (CE). At any point in this process further information could be requested from the site (usually part 2), and the NHS Direct Medical Adviser on the project could contact callers to obtain further information on the reported symptoms, such as whether they had been associated with any other features of illness or whether the illness had worsened. If the project epidemiologist believed that the information necessitated further investigation, then details were passed to the relevant Regional Epidemiologist (RE) to allow follow-up by existing public health mechanisms (involvement of the RE is termed an ‘alert’). Where appropriate, electronic bulletins to pass information to a wider range of public health professionals were issued.

A weekly bulletin was produced using the NHS Direct call data from November 2001 including description of ‘exceedances’ of algorithm calls and graphs of the data for each NHS Direct site.

**Proportion of fever calls**

Following an increase in the proportion of fever calls, noted in January 2002 (see Results), fever calls as a proportion of all calls were calculated for the age groups: 0–4, 5–14 and >14 years for the periods 17 December 2001 to 10 January 2002 (before the increase in fever calls) and 11 January to 10 February 2002.

**Results**

Daily reporting from NHS Direct sites to the HIU was sporadic at first but increased from a daily average of 13 sites during the first month of reporting (December 2001) to an average of 19 of the 23 sites during July 2002.

Figure 1 gives an overview of the data for five example algorithms between December 2001 and July 2002. Activity in some of the algorithms, such as rash and cough, vary considerably between weekdays and weekends, with peaks of activity over bank holiday periods. As expected, a seasonal pattern is also
beginning to emerge, with higher activity in some algorithms (e.g. cough) over the winter and some (e.g. diarrhoea) over the spring.

Figure 2 shows the national call rate for all calls and the calls resulting in use of the fever algorithm as a proportion of total calls between 1 November 2001 and 31 March 2002. The proportion of fever calls rose from 4.6 per cent (223 fever calls) on 10 January 2002 to a peak of 9.5 per cent (698 fever calls) on 3 February 2002. The proportion of fever calls started to decrease on 4 February and had returned to below 5 per cent by 21 February. The proportion of calls about fever rose at 15 of the 17 sites that reported regularly throughout the time period of the national increase. The highest proportion was noted at East Midlands NHS Direct (17 per cent) and the most prolonged rise occurred at Manchester NHS Direct (40 days). Fever calls as a proportion of total calls was highest for the 0–4-year-olds (peaking at 22 per cent, Fig. 3). The greatest rise in the proportion of calls (117 per cent) was in the 5–14-year-olds and there was a small decrease in the proportion of fever calls in adults over 65 years (Table 1).

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**Fig. 1** Calls for Cold/flu, Cough, Diarrhoea and Rash expressed as a proportion of the total daily calls (England NHS Direct), 19 December 2001 to 31 July 2002.

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**Fig. 2** Total call rate per 100,000 population and fever calls as a proportion of total calls.
Table 2 shows the number of confidence limit exceedances from December 2001 to July 2002. There were 919 confidence limit exceedances. The highest number of exceedances was in the ‘cough’ algorithm and the lowest was in the ‘rash’ algorithm. Table 3 demonstrates control chart exceedances and the level of investigation undertaken for each of these. This was described from February 2002 as data were able to be analysed from that date.

Experience so far has demonstrated no evidence of any deliberate release of biological or chemical agents, nor has there been evidence from any other sources that such an event has occurred within the United Kingdom. However, we have detected high levels of activity in specific algorithms at both national and regional levels, resulting in seven alerts (Table 4).

### Discussion

The events of 11 September 2001 in New York, and the following deliberate releases of anthrax in the United States, have led to a realization of the need for early preparedness, including surveillance for effects of chemical and biological attacks. As far as is known, ours is the only project of its kind in the world covering a national population, therefore there has been little opportunity to learn from the experiences of others. However, the experience of syndromic surveillance in Emergency Departments in New York City following the September 2001 attacks has recently been reported. Epidemic Intelligence Surveillance Officers provided 24 hour coverage at 15 sentinel Emergency Departments and recorded data on-site. This was felt to be costly and resource intensive and therefore unsustainable after the 30 day term of the project. Amongst the difficulties reported with this project was the lack of baseline data, which contributed to false alarms. A recommendation from the report was that in establishing early warning systems for bioterrorism, consideration should be given to seeking routinely collected electronic data.

Although a number of primary care routine and enhanced surveillance systems for a variety of infections and communicable disease conditions are established in England and Wales,
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Total numbers of exceedances may reflect data availability.
none have the country-wide coverage or report in as timely a way.\textsuperscript{2–4} NHS Direct data are collected on a daily basis and allow baselines to be established over time, although use of these data for the surveillance of symptoms occurring in the community is still at an early stage. Moreover, we are still going through the process of establishing baselines and defining the statistical methodology. Regarding the costs of this project, this work has so far been funded within existing resources of NHS Direct and CDSC and makes use of data that are relatively easily obtained within NHS Direct.

To date, we have not yet demonstrated advance warning of a deliberate release of either chemical or biological agents. A national, sustained, rise in fever calls to NHS Direct during January 2002 may have been due to an influenza-like illness in the community but this was difficult to establish without patient samples. However, unless we routinely collect and analyse data to establish baseline levels of activity using the algorithms monitored, we will not be in a good position to determine abnormal activity when it does occur.

To obtain greatest value from this project, once the integrity of the data has been established, it is necessary to develop a system where if necessary callers to NHS Direct with specific symptoms could be contacted for the purpose of obtaining samples for microbiological testing. In this way, if there were to be a surge of calls from people complaining of, for instance, influenza-like symptoms, samples could be obtained from a proportion of callers. This might allow early identification of an outbreak of influenza, or other respiratory viruses, or alert the public health community of suspicion that these symptoms could be caused by another agent such as anthrax, plague or smallpox. A protocol for a study that would determine the feasibility of obtaining samples from callers is currently being constructed.

One way of establishing the value of this work as a surveillance tool would be to compare the information we receive and the action we take against a confirmed communicable disease outbreak that caused a substantial amount of illness in one region or even at a national level. Illness caused by gastrointestinal or respiratory pathogens captured on existing surveillance systems would allow us to determine whether analysis of NHS Direct data gives any added value over current systems. We are making such comparisons, although it will be easier to conduct such investigations once data have been collected over a period of at least 12 months, as we will be able to be more confident of baselines over the seasonal cycle.

**Conclusions**

It is as yet too early in the evolution of this project for us to state with confidence that analysis of NHS Direct data will provide a symptom surveillance system in the community with value in addition to existing systems. At this stage, we feel that this project has such potential: further work and events will demonstrate whether or not this is indeed the case.
Acknowledgements

We thank the NHS Direct sites and the Health Intelligence Unit for provision of the data; David Hunt and Roland Salmon for providing consultant epidemiologist support for the project; Richard Wilson and Andrew Stevens for allowing, at short notice, Sarafina Cotterill to be seconded to this project; Angus Nicoll for his support and comments on the manuscript.

References

4 Available at http://www.hpa.org.uk (16 October 2003, date last accessed).

Accepted on 8 August 2003