Using routine health data for surveillance of the health effects of floods

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1. Background

Floods are the most common natural hazard in Europe. In the World Health Organization (WHO) European region, 1000 people were killed and a further 3.4 million people were estimated to have been affected by flooding in the last 10 years[1]; but the exact number of those indirectly affected by the widespread consequences of flooding is unknown.[2]

The 2013 European WHO review of the health effects of flooding and health response concluded that: "The epidemiological data on the health effects of flooding are incomplete. For future events, information should be obtained on health before, during and after floods. A standard reporting system of health effects should be used in each flood event, in order to build the evidence base on acute and chronic effects, from the immediate response to completion of recovery."[1]

Setting up a bespoke epidemiological study in the event of a flood may not be practical; therefore development of a set of indicators using routinely available health data could be particularly valuable. Measuring health effects of a flood has two purposes:

- to provide information on the affected population's health during ("real-time"), and in the aftermath of, a flood in order to deliver clinical, public health and societal interventions to improve health and wellbeing
- to provide epidemiological evidence of the health effects of flooding to inform research, future planning, prevention and management strategies

Public Health Adaptation Strategies to Extreme weather events (PHASE) is a three year project, funded by the Executive Agency for Health and Consumers (DG Sanco) within the European Commission Health Programme 2008-2013. Work package five "Adaptation tools to prevent the health effects of flooding", includes an objective for identifying public health tools and guidance to improve preparedness and response to the impact of floods.

The aim of this report, under PHASE, is to identify and assess the types of health indicators that could be used in surveillance to measure health impact in flood-exposed populations, using England as an example. The report contains sections: reviewing the methods used to study the health effects of flooding (section 2); possible sources of health data after flooding (section 3); and developing a suite of indicators for use after a flood (section 4). Recommendations are made for a provisional surveillance programme for England, which other European countries could use as a guide for designing their own systems, depending on what is available and feasible in their country (section 5). Preliminary findings from piloting this system in England following the floods of winter 2013-2014 are discussed.

2. Reviewing the methods used to study the health effects of flooding

In order to design a surveillance strategy to quantify the health impact of a flood, the methods used in previous studies should be described. This section summarises the types of health impact previously reported, indicators used, study designs and methodological considerations.

2.1 Methods

Health indicators of flood impact were summarised from three key systematic reviews, which had been conducted within the last three years:

1. Floods in the WHO European region: Health effects and their prevention.[1] This review looked at all papers produced on health impact of flooding from 2004 to 2010, including grey literature.
2. Examining the relationship between infectious diseases and flooding in Europe. A systematic literature review and summary of possible public health interventions.[2] This paper summarised peer-reviewed literature on water-borne illness, vector-borne illness and rodent-borne illness from 2004 to 2012.
3. The effects of flooding on mental health.[3] This report summarised reports on mental health impact and the potential causal pathways, including stressors such as economic impact from 2004 to 2010.

Information on the studies discussed in these reviews was collected, including: country and year of study, health outcome measured (with details such as case definition, International Classification of Diseases (ICD) code etc, where available), data source and method of data collection, study design, effect size (with statistical significance), time of study in relation to the flood, and other relevant notes. Where necessary, the original papers referred to in the systematic review were consulted for further information on indicators used. All studies were included, independent of quality. Only floods in Europe, Australia and North America were included, with the exception of one study of skin infections in Taiwan due to the lack of other available evidence. On expert advice, a further paper on heavy rainfall and outbreaks in England, which is outside the literature timeframes above, was included.[4]

The information was used to populate the table in Appendix 1.

2.2 Results and discussion

Results are presented in Appendix 1.

2.2.1 Variations in measured effect size

Studies of the same health outcome often showed wide variation in effect size, for example prevalence of post-traumatic stress disorder post flood varied from 3.6% to 50.5%, and number of direct deaths varied from none to several hundred.[1]

These wide variations in effect size are in part a reflection of the vast heterogeneity of floods themselves – the speed and scale of inundation, flood duration and how much warning there was, as well as the accompanying hazards of the flood: cold, humidity, strong winds, power failures, chemical contamination, sewage leaks etc. Other reasons for the variation include the heterogeneity in the population exposed and their ability to respond and adapt, and the support they received in the emergency and recovery phases. The study methodology will also affect the measured magnitude of effect by affecting data quality and case ascertainment, such as time period post-flood, active vs passive surveillance etc.

The timing of the study plays an important role in the effect size identified. Most studies have been cross sectional, assessing health reports at a certain point post flood, with longitudinal study designs being rare. This limits the evidence for the health impact to the specific timeframe measured, meaning that diseases with a long latency or chronic impact are less well characterised. Conducting longer term studies comes with methodological difficulties, as unless well planned they may result in dilution of any effect measured as people are lost to follow up and migrate in and out of the affected area. This is a particular problem with flooding as many people are temporarily or permanently displaced. A recent analysis of population displacement in a city in northern England found a massive 59% of flooded households were displaced.[5] Although it is recognised that people die as a direct result of floods, with 13 people losing their lives during the UK's summer 2007 floods[6], a study of 319 floods from 1994-2005 in England and Wales identified a decrease in mortality of 10% in the 12 months post flood.[7] This apparent contradiction was likely to be due to migration out of the area after the flood, and the effects of this need to be borne in mind when considering a surveillance strategy.

Finally, it was noted in particular for mental health outcomes that case definitions varied[3], making it difficult to compare studies, in particular when symptoms were measured subjectively or through self-reporting.

2.2.2 Study designs and sources of health data

The research methods used to assess health impact varied from observational studies describing trends in routine health data in flood-affected areas to analytical epidemiological studies linking detailed exposure data to health data, as well as community surveys, emergency response and outbreak investigations. Most studies were cross sectional, usually describing prevalence of symptoms in the preceding period. For most studies, exposure was assigned based on geographical units, where the entire population living in an administrative area was assumed to have the same exposure status. Community surveys and interviews tended to be conducted to assess the incidence of more chronic diseases or the impact on those conditions where good routine health data were not available, such as mental health, coughs and mild injuries.

Table 1 summarises the main health outcomes identified in the literature and the sources of data used in the studies.

Other potential health impacts of flooding were discussed in the literature reviews but no specific studies were presented, such as the impact of fires caused by floodwater (burns or smoke inhalation), electrocution, drug and alcohol dependence, violent behaviour and increases in dust mite exposure.

Table 1: Health outcomes studied after floods and sources of health data[1,2,3]

Health outcome	Sources of health data
Mortality	Routine data: Death certificates/mortality data Emergency response databases
Chemical exposure	Routine data: poisoning calls to helplines Routine data: hospital visits
Water borne infections	Emergency outbreak investigations Community surveys Routine data: hospital visits Routine data: laboratory reports
Vector borne infections	Emergency outbreak investigations Routine data: hospital visits Routine data: laboratory reports
Mental health	Community surveys Routine data: prescription data
Respiratory symptoms	Community surveys
Injury	Community surveys

2.3 Conclusions

Although Appendix 1 does not represent a complete, detailed dataset of all studies undertaken into the health consequences of flooding, it provides an overview of the types of health outcome that could be expected in Europe post flood. It also identifies sources of data that may be used to measure impact and allows key themes to be identified.

It can be concluded that measuring the health impact of flooding is more straightforward for some health outcomes than others. Good routine statistics exist in most European countries for mortality or for unusual diagnoses such as leptospirosis, whereas for common, mild outcomes like cough, or diseases with long latency and a subjective nature such as anxiety and stress, the variation in study design leads to a greater heterogeneity in the results. However, even if health data are robust, linking disease to the flood itself can be problematic, in particular when there may be many potential factors (which are often immeasurable) on the causal pathway. With every flood being so vastly different in context, it would be difficult to assign measured health impact to flooding in general.

3. Sources of health data after flooding

In this section, useful sources of data that are likely to be available in some capacity in all countries in Europe are explored, including the advantages and disadvantages of including them in a surveillance programme for flooding.

3.1 Incident data

Incident data will include information gathered during the emergency response to the incident, such as through multi-agency strategic meetings or public health response networks. In England, for example, events are reported to Public Health England (PHE) regarding flood-related chemical contamination or fires, and microbiological results from floodwater sampling may be provided for public health risk assessment and advice. PHE staff directly respond and investigate events such as carbon monoxide poisoning and infectious disease outbreaks. In particularly large events, such as the floods associated with Hurricane Katrina, emergency health databases may be set up to record deaths directly linked to the event.[1]

Advantages:

- data are directly related to the flood, and therefore do not require extrapolation or interpretation
- information gathered forms part of the immediate public health response
- exposure measurements can be used to target health surveillance

Disadvantages:

- many reports of health effects are anecdotal and not collected systematically, therefore they are not quantified or validated

3.2 Ad hoc data

These are data that are collected specifically in response to the flood through *ad hoc* epidemiological studies, which are usually planned after the event. Examples may include cross-sectional surveys on mental health disease, or a longitudinal cohort study of a flooded population.

Advantages:

- exposure metrics can be gathered alongside illness in surveys, thus improving link between cause and outcome
- mild illnesses that may not require healthcare professional advice can be identified through community surveys and interviews
- rare or unusual outcomes can be identified as data are collected on an individual basis

- the scope for collecting information on a variety of outcomes, including those not usually collected in routine data, such as sleeplessness or fear

Disadvantages:

- the requirement for planning for special data collection and work at local level, involving significant money and resources
- research usually requires ethical approval, delaying the start of data collection and making it unsuitable for informing immediate public health messages
- the potential for reporting bias as participants are more likely to self-select their inclusion into the study if they have had symptoms.
- recall bias may occur after a delay in beginning data collection

3.3 Routine surveillance data

This section explores the use of different types of routine health data sources. General advantages and disadvantages of using routine sources of health data are included here, with source-specific issues described under each sub-heading.

Advantages:

- existing datasets do not require any special data collection or extra effort on behalf of the people on the ground
- depending on how often they are collected and made available, some routine data can be interrogated immediately, providing near real-time situational awareness for public health response
- datasets are often well understood with historical baseline levels, allowing more robust interpretation of changes and identification of exceedances
- longitudinal data are available for identifying trends
- data are objective

Disadvantages:

- only cases reported to that healthcare system are counted
- data may lack the sensitivity needed to pick up small changes in case numbers due to the flood, or lack power when only a small population is affected
- data are often aggregated to administrative boundaries, making it difficult to link health outcome with flood exposure

3.3.1 Mortality data

Mortality is a basic indicator of health, and statistics are available for all European countries, with annual data submitted to the World Health Organization[8] and weekly, raw data submitted for monitoring public health threats to EuroMOMO.[9] Cause of death is usually coded according to the WHO's ICD, 10th revision (ICD-10)[10]; individual-level data, such as age, sex and place of death, are available and can be used to link deaths to the flood-affected area.

Most studies of flooding using routine mortality data have looked at all-cause mortality, although some have looked at specific ICD codes such as drowning or cardiopathies.[11] The ICD-10 code "X38 Exposure to forces of nature:- Victim of flood" describes the circumstances causing the injury, not the injury itself, so is not used as a principal diagnosis; however WHO data show X38 was indicated as the underlying cause of death seven times in Europe in 2010.[9] Suggested ICD-10 codes that could be considered in association to flooding are given in Table 2.

Summary of evidence from data source:

- Every death is recorded and reported in European countries, providing reliable data
- Flooding may cause death indirectly after a long period with many potential factors on the causal pathway, making it difficult to attribute a death to the flood
- Mortality is useful for providing long-term evidence of health impact for research purposes

3.3.2 Hospital data

Hospital data may indicate illness requiring specialist treatment. Data available may include emergency department visits (triage and/or diagnosis), admissions (inpatients), consultant appointments (outpatients) and discharge data. Like mortality statistics, datasets in Europe are usually available coded to ICD-10 but may also be coded to the International Shortlist for Hospital Morbidity Tabulation in Europe.[12] Potentially relevant ICD-10 codes are listed in Table 2. Individual hospitals may also be able to make data available in real time. Most hospital surveillance after floods has followed this method. For example teams from the Centers for Disease Control visited hospitals in Louisiana after the Hurricane Katrina floods to identify injuries and diseases.[13]

Summary of evidence from data source:

- aggregated hospital episode data are often collected to allow hospitals to be paid for the care they deliver, making the data reliable but usually unavailable in real time
- hospitals may have a wide catchment area including flooded and non-flooded areas; individual records with address data would be required to assign each episode to a flooded / non-flooded area (although this would not show exposure definitively)

3.3.3 Ambulance data

Ambulance calls have been shown to respond to extreme cold and heatwave events, with total daily call counts increasing during severe weather.[14] With increases observed in injuries and cardiovascular events during floods, it is likely that ambulances will be called and this is a possible source of data that can be explored to provide real-time information.

Ambulance call data has the potential to directly link health impact to flood events. First, ambulances are deployed directly to the address at which the health event has occurred and this can be used to link the call to exposure if the geographical details of the flood, and evacuation centres, are known. Second, callers will usually be asked if the illness or injury is related to floodwater in order to assess accessibility and specialist equipment requirements, and ensure paramedic health and safety. This information may be recorded. In England, for example, Hazardous Area Response Teams are deployed to flood calls as they have received specialist training in floodwater.[15]

Summary of evidence from data source:

- possible to link ambulance data directly to the flood
- ambulance call data are available in real time
- records are usually categorised based on information provided by the caller (non-medical members of the public) and therefore may not accurately reflect the health complaint

Table 2: Potential health outcomes of floods identified in literature reviews, with suggested codes from the World Health Organization's ICD-10[10]

Potential health outcomes of floods	Potential ICD-10 codes of interest * #
Mortality – all cause	All *Supplementary code*: X38 Exposure to forces of nature → Victim of flood Category may be used to provide supplementary information on cause of mortality
Cardiopathies and cerebrovascular accidents	I20-I25 Ischaemic heart diseases I60-I69 Cerebrovascular diseases
Drowning	T75.1 Drowning and nonfatal submersion
Electrocution	T75.4 Effects of electric current W86 Exposure to other specified electric current W87 Exposure to unspecified electric current
Hypothermia	T68 Hypothermia X31 Exposure to excessive natural cold
Injury/physical trauma	S00-S99 Injuries T00-T07 Injuries involving multiple body regions T08-T14 Injuries to unspecified part of trunk, limb or body region
Carbon monoxide poisoning	T58 Toxic effect of carbon monoxide Y17 Poisoning by and exposure to other gases and vapours, undetermined intent
Smoke inhalation	X00-X09 Exposure to smoke, fire and flames
Burns from fires/chemicals	T20-T25 Burns and corrosions of external body surface, specified by site
Effects of chemical exposure	T52-65 Toxic effects of substances chiefly non-medicinal as to source (*excl T51 Alcohol; T61 noxious substances eaten as seafood; T62 other noxious substances eaten as food; T63 contact with venomous animals; T64 aflatoxin and other mycotoxin food contaminants*). The main codes likely to be of interest are: • T52 – toxic effects of petroleum products • T55 – toxic effects of soaps and detergents • T59 – toxic effects of carbon monoxide X46 Accidental poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours X48 Accidental poisoning by and exposure to pesticides X49 Accidental poisoning by and exposure to other and unspecified chemicals and noxious substances *Supplementary code*: Y97 – Environmental pollution-related condition. Category may be used to provide supplementary information on cause of morbidity
Suicide and self-harm	X60-X84 Intentional self-harm
Stress	F43 Reaction to severe stress and adjustment disorders
Post-traumatic stress	F43.1 Post-traumatic stress disorder

Potential health outcomes of floods	Potential ICD-10 codes of interest * #
disorder	
Anxiety	F41.1 Generalised anxiety disorder F41.2 Mixed anxiety and depressive disorder
Depression	F32 Depressive episode F33 Recurrent depressive disorder
Gastroenteritis, diarrhoea, vomiting	A00-A09 Intestinal infectious diseases
Soft-tissue infections (wounds)/cellulitis	L03 Cellulitis
Leptospirosis	A27 Leptospirosis
Fungal infections	B35-B49 Mycoses. Although this is a code, these diseases are rare (never seen) in association with flooding
Respiratory symptoms	J45 Asthma R05 Cough
Insect bites/stings	W57 Bitten or stung by non-venomous insect and other non-venomous arthropods

*Codes given to three characters where all diseases in that family are of potential relevance or to four characters where only specific diseases are of relevance.
#Whereas effort has been made to only list ICD-10 codes of potential relevance to flooding and its consequences, medical and subject-matter experts should be consulted as to their accuracy.

3.3.4 Family doctor data

Analysis of family doctor (or general practitioner (GP)) data could be used to describe disease complaints and public concern in the community. They are particularly useful to show mild illness. No studies described in the systematic literature reviews used family doctor data to show health outcomes post flooding. A unified routine dataset of family doctor data is currently unavailable in England.

Summary of evidence from data source:

- routine data from family doctors, where available, can be used to inform levels of mild illness in the community

3.3.5 Poisons centre data

Chemical poisoning advice is usually provided through dedicated poisons information centres across Europe. These may operate on a national basis, such as the Giftinformationscentralen in Sweden, or centres may operate regionally such as in Italy.[16] Calls may be accepted from clinicians only, representing more severe disease (such as in the Netherlands), or from members of the public also, which can represent less severe disease (such as in Sweden). However, as poisons centres are a central point of information for anyone concerned about chemical exposure, even those taking clinician-only calls are likely to receive reports covering a wide range of symptom severities. The UK's National Poisons Information Service (NPIS), for example, receives calls from staff at telephone health helplines, family doctors and clinicians treating hospital patients who are treated and discharged, as well as those who go on to be admitted.[17] Although not a feature of all floods, chemical poisonings have been known to occur, particularly from loss of power supply resulting in incidents involving fuel exposure or carbon monoxide in fumes. After the Hurricane Katrina floods, calls from the public to a poisons centre increased by 13%, particularly in relation to lamp oil and carbon monoxide; however many of these were for information only and not related to actual poisoning.[1]

Increasingly, healthcare professionals are using online toxicological databases for advice rather than calling. Indeed the NPIS report that the vast majority of queries now come via their web platform Toxbase.[17,18] Trends in web page views for specific chemicals during and after floods may be useful, although care should be taken in interpreting whether increased page accesses are for actual poisonings or for educational purposes.

Summary of evidence from data source:

- Likely to include data for patients across a range of symptom severities, presenting to different parts of the healthcare infrastructure
- Due to low numbers of cases of significant poisonings associated with floods, data from poisons centres that deal directly with members of the public may be more useful than centres that only take calls from clinicians.

3.3.6 Laboratory data

Infectious diseases that have been associated with flooding in Europe include leptospirosis, norovirus and non-typhoidal salmonella, among others.[2] Many patients with gastrointestinal illness will self-treat or be treated by family doctors without laboratory diagnosis; a UK study showed that for every case reported to national surveillance, there are 10 family doctor consultations and 147 community cases.[19] Samples would be submitted for laboratory confirmation for more severe cases or on suspicion of an unusual pathogen such as leptospirosis. Reporting of some laboratory-confirmed pathogens such as *Campylobacter* species is mandatory in most countries in Europe.[19] Routine laboratory diagnosis data have been used often in flood-related research for both gastroenteric pathogens and zoonotic diseases.[2]

It may also be possible to use data from laboratories that test for chemical exposure. The main acute chemical hazard associated with flooding is carbon monoxide poisoning, but this is diagnosed at point-of-care without the need for laboratory tests. However, if the flood context suggests that chemicals have been released and significant exposure may have occurred, then specialist laboratories could be contacted. For example, over 200 onshore releases of hazardous chemicals, petroleum and natural gas were reported as a result of Hurricane Katrina.[20]

Summary of evidence from data source:

- laboratory data represents confirmed diagnosis of disease and given mandatory reporting for some pathogens, data is reliable and accurate
- depending on the country's system, laboratory data is near real time, with many reports being sent from the laboratory to both the treating clinician and public health centre simultaneously.

3.3.7 Prescription data

Medicines prescribed by clinicians in community healthcare centres provide indications of types and rates of illness in the community. Indicator treatments may include antibiotics for water-borne illness, respiratory disease or skin infections, or anti-depressants for mental health diagnoses.

Prescription data available through health insurance systems were used to identify the short-term mental health impact of flooding in France in 2010.[21] Daily counts of new psychotropic drug prescriptions (for patients who had not received them in previous six months) were analysed for 18 months pre-flood and 10 months post-flood. The analysis showed that the relative risk of prescription of new antidepressant, tranquiliser and hypnotic treatments was greater in the 21-day period post flood than expected (RR=1.53 (95%CI 1.39-1.61).

In the French example, data was obtained from insurance companies and in England, data is submitted by GPs. In both example systems, data is collected to provide financial reimbursement for the cost of medicines.

Pharmaceutical drugs can be classified in various ways: the European Anatomical Classification of Pharmaceutical Products[22] is a system that could be used to identify relevant products. In England, prescription data are available in groups classified by the British National Formulary[23] from NHS Prescription Services.

Summary of evidence from data sources:

- prescription data are unlikely to be available in real time
- data may have good granularity (down to local family doctor level), which will provide improved accuracy with regard to assigning flood exposure.

3.3.8 Over the counter medicine sales data

Analysing sales data for over-the-counter medicines available in pharmacies and other shops (ie medicines not requiring a clinician's prescription) may provide information on symptoms in the community that are not severe enough to require formal medical attention. The relationship between over-the-counter sales of cough and cold remedies has been found to predict the volume of patients attending urgent care centres for flulike illness.[24] In the months following the Hurricane Katrina floods, 37% of participants in one survey reported having coughs[25]; an increase in demand for cough syrups and expectorants could be predicted. Another potentially interesting area could be sales of sleeping tablets (where available over the counter), as many people report sleeplessness after floods.[3,6]

Summary of evidence from data source:

- these are commercial data so may not be easily accessible to public healthcare professionals
- useful for indicating mild illness in the community
- different medicines may be available over the counter versus by prescription-only

3.3.9 National health helplines

Health information and advice lines ("telehealth") may exist in some countries, staffed by nurses, doctors or other professionals, to give remote health advice to members of the public. These helplines may collect information on symptoms and diagnosis, but can also be used to give direct information on flooding.

Summary of evidence from data source:

- indicates level of community concern about the flood but does not describe diagnosed cases of disease
- may be available in real time

3.3.10 Syndromic surveillance data

Syndromic surveillance can be defined as the collection, analysis, interpretation and dissemination of health-related data on a real-time (or near real-time) basis, and typically consists of aggregating symptom data into a syndrome. Syndromic surveillance systems are not designed to collect exact numbers of diagnosed cases of a specific disease, but to describe groups of symptoms (syndromes) at population level, meaning that data is often available pre-diagnosis (ie before potentially lengthy medical tests/laboratory reports) and thus provide different information to the systems described previously in this section. Syndromic information may be collected from various sources of health data, such as: pharmacy sales, prescription data, health telephone helpline calls or websitevisits, and healthcare visits to family doctors, walk-in centres or hospitals.

Many European countries have syndromic surveillance systems in place. An inventory of existing and proposed syndromic surveillance systems was collated during the Triple S Project (Syndromic Surveillance Survey, Assessment towards Guidelines for Europe), describing the systems in 16 countries.[26]

Summary of evidence from data source:

- provides rapid situational awareness of any health effects of the flood, which can be used to inform public health interventions
- data are pre-diagnosis, so may not be accurate
- studies have shown that syndromic surveillance systems can provide earlier warnings of the impact of infectious disease outbreaks (eg influenza, norovirus) than laboratory reporting[27,28] and therefore may have some benefit in responding to flooding

3.3.11 Other data

Additional routine datasets are likely to be available in different countries and useful indicators may already exist. For example, specialist health centres such as asthma clinics may provide routine automated data to public health departments.

Occupational health records could be a rich source of data, both for workers who may have been exposed to floodwater or involved in cleaning up, and for emergency services and local authority staff who attend the scene to assist and support locals.

Proxy data could be used to indicate health and social impact in the community, although they would usually indicate consequence of disease, not the disease itself, such as sick leave, school absenteeism, uptake of counselling or support groups. Visits to the PHE website increased dramatically from an annual mean of 16 views per day to a two-day mean of 128 views after flooding in Cornwall in November 2010, with most of the page views coming from Cornwall (unpublished data).

Contextual and anecdotal evidence from charities (those delivering care on the ground or helplines), insurance companies and citizens advice bureaus could be used.[29]

4. Developing a suite of indicators after a flood

Section 3 has discussed the wealth of sources of routine health data that are typically already available to public health professionals that can be used in surveillance after a flood. These can be used to develop indicators to describe the impact of the event. Choosing the most appropriate indicator will depend, among other factors, on the health outcome of interest and what data sources are already available, which will vary by country across Europe. This section discusses some of the issues that need to be considered when developing a suite of indicators.

4.1 What makes a good indicator

A health indicator is a quantifiable variable or characteristic that can be used to describe health status, determinants of health or healthcare systems in a population. Indicator data are often gathered using a survey methodology and then generalised to the population of interest to draw conclusions about its health status.

Health indicators are powerful tools for monitoring and comparing the health of a population, and can be used in planning and policymaking and to track the progress of interventions.

Indicators may be counts, proportions, rates, ratios, averages, or may simply note exceedances or direction of effect (increase or decrease). The indicator is made up of data and metadata:

- title
- rationale - why the indicator is important
- definition – a succinct explanation of what is being measured, eg calls to telephone helpline regarding flooding expressed as a percentage of all calls
- data source
- who is measured and when, eg population subgroups, data collection frequency
- domments and caveats - accuracy, completion rates, strengths andweaknesses

A good indicator requires good metadata to define it accurately, as well as high quality data. A poorly chosen indicator with good data, or a well-chosen indicator with unreliable data can lead to inappropriate conclusions and decisions. An indicator can be designed to quantify an expected health impact, but for practical reasons, indicators are often chosen on the basis of what data is available. Data availability is a major limitation to designing a surveillance programme.

According to DG SANCO[30], a good indicator should be:

- easy to read and understand
- relevant
- mutually consistent
- available in a timely fashion
- comparable between different geographies
- selected from reliable sources
- not overly imposing on health providers, public health departments and other respondents

In addition, indicators should have high levels of:
- validity: the data measurement or test accurately measures what is intended to be measured
- reliability: the consistency of the data when collected repeatedly using the same procedures under the same conditions
- sensitivity: the data will change if the situation changes
- specificity: the data reflects only the situation concerned
- feasibility: can actually be collected
- relevance: actually describe situation of interest

and be:
- unbiased: collection and interpretation of the data avoids systematic error in one direction
- action focussed: inform decision making
- timebound: progress can be charted

4.2 Factors to consider when choosing an indicator for floods

4.2.1 Surveillance system

Surveillance systems already available are likely to be a main factor in choosing an indicator. Some indicators may already be in use for other public health purposes, whereas others can be developed for use specifically in floods. The data provider or information officers should be consulted to discuss how useful the data will be and any caveats, regarding the following:
- baseline rates
- data on health episodes
- data level (population vs individual)
- sensitivity of surveillance system
- bias in indicator choice

Baseline rates are usually available or can be calculated using routine surveillance data. These are required to understand if a flood has had an impact or not – ie if there have been significant changes above what is expected.

Data on health episodes may be available immediately or within a day or so, and can be classified as 'real-time'. These data are useful for situational awareness and so should be used for health outcomes where public health interventions and messaging are important for immediate prevention. They will lack the accuracy of data that have been cleaned before being published.

Most routine datasets are available at population level (based on a geographical unit such as a health administrative area) rather than an individual level, making the linkage between exposure and outcome difficult.

Sensitivity of the surveillance system to pick up a signal above the noise must be understood. Small changes in expected vs observed counts are unlikely to be identified as a significant exceedance if the system covers a large population. A system available at smaller geographical units may be more accurate in assigning flood-exposed or unexposed status on a population level, as there will be more homogeneity of exposure; however, a smaller population may not have sufficient statistical power to identify changes or rare diseases. In addition, some datasets are aggregated into time periods such as weeks, months, quarters or years, making it harder to identify short-term changes.

There is potential bias in choosing indicators according to what routine datasets are already available. Leptospirosis is a rare disease in Europe yet there have been numerous publications on the disease in relation to flooding.[2] This is most likely due to the robust diagnostic and surveillance systems in place for the disease, and not because of its relative importance as a consequence of flooding. Other diseases, such as mental health disease, are less well covered by routine data sources, but are known to have a wide impact,; a lack of available data in the aftermath of a flood may lead to the incorrect assumption that the impact has not manifested, when in fact it just has not been enumerated.

4.2.2 Health outcome of interest

In order to develop a relevant indicator to measure the impact of the flood on a particular health outcome, experts in the disease should be consulted. They can provide context regarding:

- healthcare provider most often contacted
- average incubation period

People with certain illnesses are more likely to visit certain healthcare providers than others; for example those with depression are more likely to present to their family doctor than a hospital emergency department. Scenario testing of syndromic surveillance found that small, localised incidents involving food poisoning were most likely to be detected the next day via emergency department surveillance, while a new strain of influenza was more likely to be detected via GP or telephone helpline surveillance, several weeks after the first seed case is introduced.[31]

Surveillance timeframe will differ for different diseases and syndromes, for example gastroenteritis due to a salmonella infection may have a half-day incubation period, whereas the same symptoms due to a cryptosporidium infection may only manifest after 28 days. This is particularly a problem for those diseases that are a result of a complex causal pathway, such as mental health conditions. A study described in Murray et al[3] found that the self-reported 'worst' time for those affected by flooding was three months post flood, yet there is a wealth of evidence that mental health impact can continue for many months and years. This may also differ by country: it is generally acknowledged that mental health symptoms such as distress and anxiety in the immediate aftermath of a flood are to be expected, but if they persist beyond four weeks then they are moving towards a disorder for which medical advice should be sought.[1,3,] A study in France, however, showed a significant increase in medical prescriptions for psychotropic drugs within the first 21 days post flood.[21]

4.2.3 Flood context

An understanding of the specific flood's context is required when deciding which indicators to use. The scale of the flood will suggest whether population-based indicators are likely to be useful to identify impact. Some flood events may affect only a small number of houses, or many houses but over a dispersed area, meaning that data based on administrative boundaries may not be useful. A decision could be made to 'switch on' some indicators according to the numbers of people affected, for example if less than 100 households affected indicators x, y and z could be used, whereas for 100-1000 households all indicators could be used.

Flood factors such as rapid inundation or accompanying strong winds may suggest that injury indicators are more important; sewage/septic tank leaks are more likely to result in gastroenteric conditions; cold weather may lead to hypothermia.

Other local context-specific environmental factors should be considered when constructing a surveillance system, such as endemic pathogens (hantavirus, West Nile virus etc), or farmland and slurry run-off (zoonotic gastrointestinal infections). Specific chemical releases would suggest that poisons centre data may be particularly useful; new indicators could be developed in light of what is known about the chemical.

4.2.4 Vulnerable groups

An indicator could be designed just to look at impact in certain sub-groups or vulnerable groups. For example, it is possible that gastroenteritis in relation to flooding is more common in children than adults, as children are more likely to have poor hygiene standards such as not washing their hands after coming into contact with floodwater or contaminated items. Or it may be that evidence is required to answer a specific public health question: are children more vulnerable to waterborne illness after floods? The precision of the chosen indicator to answer a specific question should be considered in light of the loss of statistical power by looking at an effect in a smaller population.

4.2.5 Ethics and legislation

Data should be gathered and analysed in accordance with the relevant national legislation, ethical and patient confidentiality rules. Even if the data are already available to the researcher, it must be ensured that use of the data complies with the conditions agreed with the data provider. This may vary by whether the data are being used for emergency public health response purposes or for research. Ethical approval may be required in some countries for research.

4.3 Using multiple indicators for the same health outcome

Section 3.3 discusses how different surveillance systems can identify different levels of severity of the same health outcome, which is illustrated in Figure 1. Many cases will simply go unreported as some people will not consult a doctor; a UK study showed that for every gastrointestinal illness case reported to national surveillance, there are 10 family doctor consultations and 147 community cases.[19]

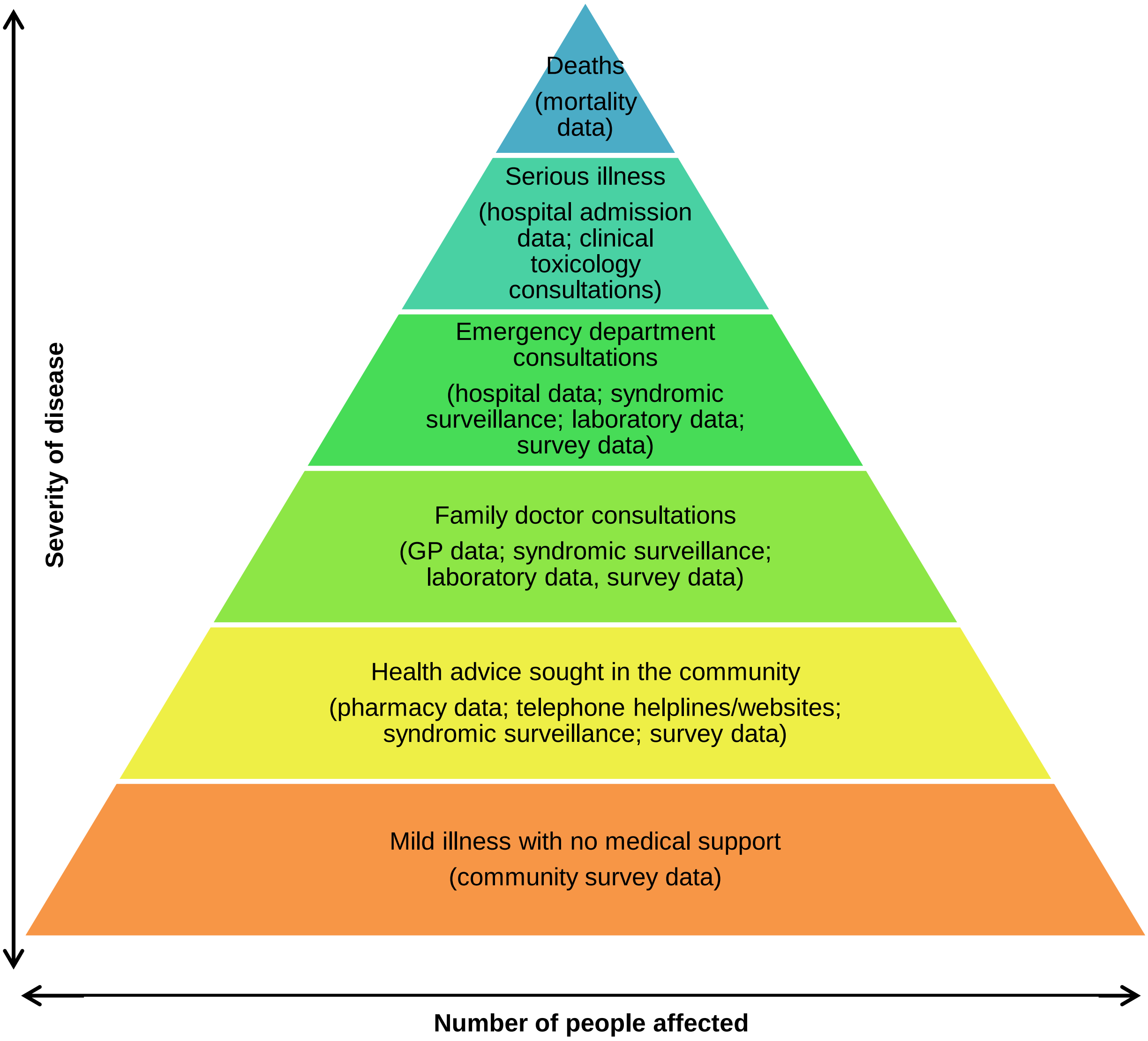

Figure 1: Pyramid showing sources of data available for measuring disease, according to severity. Mild illness in the community is likely to be most common, with fewer incidents of severe illness and death.

Using indicators from multiple different surveillance systems gives a more rounded overview of the entire impact of the flood, from mild illness to severe illness. Different indicators can augment each other and a similar signal from multiple systems validates the conclusion that there has been a health impact. However, it should be remembered that health outcome definitions will differ between indicators – some will be confirmed cases, others will be pre-diagnosis etc.

A further advantage of using multiple systems is that it allows the time course of the health outcome to be better understood, such as whether there are peaks in cardiovascular conditions during the flood and whether rates remain high, tail or peak again in the weeks post flood when mental health conditions are expected to manifest.

A balance must be sought between including multiple indicators to improve evidence, which requires more work, and duplication of effort for little additional insight.

4.4 Analysis and interpretation

Analysis and interpretation of the data for each indicator will depend on the surveillance system being used. A data dictionary or data quality statement is usually available with each dataset, which will describe each data point, method of collection and caveats such as completeness and accuracy. Information officers who are fully familiar with the dataset will be able to assist with its analysis.

Two common methods of analysis are the comparison of indicator data during the flood with data for the same area at a time point prior to the flooding, or comparing data for the area flooded with an area unaffected by flooding during the same time period. These methods compare observed effects with expected effects, with the overall aim of determining whether the size of effect is unusually high and likely to be attributable to the flood.

The ability of a surveillance system to detect statistically significant increases in a particular outcome depends on many factors such as the size of the population affected (power), the geographical distribution of the exposure, the outcome definitions used, severity of disease, health-seeking behaviour and the effect size.

When interpreting indicator data, epidemiologists should consider these aspects. Health data must be linked to a measure of exposure in order to assess impact. Defining a population as exposed or unexposed to the flood can be difficult at aggregated level. The official definition of 'flooded' can vary - such as floodwater entering the residential property, or floodwater in the garden / outbuildings - and therefore must be defined. Exposure could also be assigned according to the public health question – for example, an area affected by heavy wind and rainstorms and power loss but not floodwater could be included. As with all ecological studies, indicators describe the population and not the individual and cannot show cause. It cannot be assumed that patients presenting with complaints have been exposed to the flood.Some health outcomes may have occurred as a direct result of the flood, whereas other may be coincidental or even prevalent.

Equally, people who were exposed to the flood may have visited healthcare centres in areas not flooded, or provided alternative residential addresses due to evacuation and displacement, diluting any effect that may be found. Mass displacement is one of the most important problems in measuring the effects of flooding.

The comparison period and geography need to be chosen carefully and take into account population-based confounders, such as different demographics, seasonal patterns in disease status (such as circulating pathogens or aeroallergens), day of the week effect etc. Any changes in denominator data between years should be considered.

'No observed effect' does not necessarily mean that there hasn't been an effect; it could be because the surveillance system wasn't sensitive enough to pick up a small change. As in figure one, symptoms reported to any healthcare surveillance system represent only a proportion of all cases.

Indicators provide indication about a situation or the health status of the population and therefore do not convey all of the many nuances of the flood. Indicators should therefore not replace detailed investigations and should not be used in isolation to make conclusions. Incident data gathered as part of the emergency response or recovery, even if anecdotal, can be used to interpret indicator data.

5. Recommended indicators for measuring health impact of floods in England

Appendix 2 comprises a recommended suite of indicators that can be used to survey the health impacts of floods in England. It is provided here as an example of how a surveillance programme may look, which other countries can consider when developing their own programme. The indicators were chosen based on what is readily available currently to PHE and will need to be tested, evaluated and refined.

5.1 Use of indicators in winter 2013-2014 floods

From December 2013 to February 2014, a series of storms caused coastal surges, fluvial, pluvial and groundwater flooding across England. At the time of submission of this paper, it is still unclear exactly how many people were affected directly by flooding, but it is certainly in the thousands.

Emergency response coordinators, government and members of the public wanted information on the health effects that were being reported in relation to the floods and what precautions were being recommended for to protect themselves and the public. [32]

A surveillance cell was set up by PHE to respond to these requests and assist in the public health response. The Cell considered the below indicators; where relevant, the indicator code from Appendix 2 is given in parentheses:

- real-time syndromic surveillance data for gastrointestinal diseases from telephone health helplines and GP data (GI-GP)
- routine laboratory reports for gastroenteric pathogens, including species of non-typhoidal salmonella, shigella, giardia, campylobacter and cryptosporidium (GI-LAB)
- microbiology reports of leptospiros from reference laboratory (LEPT-LAB)
- carbon monoxide poisoning calls to National Poisons Information Service (CHEM-UKPID)
- significant event reports to the local Health Protection Teams (GI-HPZ)
- significant incident reports to the PHE Centre for Radiation, Chemical and Environmental Hazards (CHEM-CRCE)

For the final two indicators (GI-HPZ, CHEM-CRCE), a significant event was defined as “any event in England related to an infectious agent or non-infectious environmental hazard related to flooding affecting an individual or a group of individuals, which fills one of the below criteria:

- is likely to be attributable to the floods either directly or indirectly

- is likely to impact on the operational response to the floods
- is likely to be exacerbated by, or present difficulties to, the response to the floods
- is likely to be/has been the subject of media scrutiny that can be linked to the floods
- may result in widespread public concern linked to the flooding that needs to be addressed."

Not all of the indicators suggested in Appendix 2 were used, as some have not been fully developed or validated, and some health outcomes were not considered likely to trigger statistical alarms given what is known about their epidemiology in England. Others regarding long-term health outcomes will be analysed in the coming months.

For each of the indicators, existing statistical analysis methods were used to: identify whether there was a potential exceedance and rate this exceedance according to its severity and whether it required further investigation. For example, the expected number of infections linked to each pathogen for each week is calculated using Poisson regression analysis from five years of data (January 2009-December 2013).

5.2 Preliminary analysis of health data for England

Analysis of the indicators to date identified no exceedance in gastroenteritis symptoms or laboratory-diagnosed cases, no cases of leptospirosis, and no increase in carbon monoxide poisoning toxicology consultations, following the winter 2013-14 floods. Event-based data has identified cases of carbon monoxide poisoning, including two potential deaths.[33]

Using the indicators initially allowed PHE to:
- monitor and communicate information about the flood-affected population[34]
- identify diseases, and target resources and messages for disease prevention, such as providing radio messages on the dangers of using generators and carbon monoxide poisoning[35]
- raise awareness of the problems and engage multi-agency partners on collaborative action, for example by attending multi-agency meetings and encouraging partners to distribute the PHE-Environment Agency leaflet on how to stay safe during the floods to affected communities[36]
- inform policy makers and promote accountability at local level, including by the public themselves[37]

5.3 Future work

A flood epidemiology group has convened within PHE to continue analysis of the health impact of the winter 2013/2014 floods in England. Of particular relevance is work to evaluate and refine the suite of indicators used. Retrospective analysis of some real-time indicators, for example syndromic surveillance of injuries, will be conducted in order to develop statistical alarms and assess their value in future floods. A lack of data available to measure mental health impact has been noted, and work is underway to address this.

6. Discussion and conclusions

6.1 Public health importance of surveillance after flooding

Most studies conducted into the health effects of flooding have used routine sources of health data rather than active surveillance. Routine data are useful for developing indicators, which are a powerful public health tool. Many indicators that have relevance for flooding are already available. They serve two public health purposes:

- providing information on the affected population's health during ('real-time') and in the aftermath of a flood in order to deliver clinical, public health and societal interventions to improve health and wellbeing
- providing epidemiological evidence of the health effects of flooding to inform research, future planning, prevention and management strategies

Indicator data represent a rapid, objective and cheap way to show if any health impact is occurring. In order to get the best out of indicators during and in the immediate aftermath of a flood, an off-the-shelf list of indicators available to public health scientists is recommended that includes the rationale for each, data caveats and a plan for how they will be analysed and interpreted. This ensures that any infectious disease outbreaks or environmental events are detected in time for public health interventions to be implemented.

Establishing in advance what datasets are available means that gaps can be identified and addressed before a flood. A new agreement could be made to access the required data or an entirely new indicator could be developed, for example**.**In England in winter 2013-14, for instance, a need for new mental health indicators was identified and this will be addressed for future floods. Providing an overview of the entire impact of the flood as soon as possible will support ongoing public health and social interventions, as well as future planning and prevention. Negative findings are equally as valuable as positive findings, providing reassurance to the public and authorities that the disease has not arisen in the population.

By using a standardised set of indicators in each flood event, it may be possible to evaluate the effects of public health interventions. In the US, an aggressive public health campaign to raise awareness of carbon monoxide poisoning risk in power cuts following a winter storm led to a decrease in poisoning cases compared to previous storms. [38]

Nevertheless, indicators are just that. They indicate a situation and do not show cause nor fully represent the complexity of a flood, where exposures and pressures vary with time leading to multiple health outcomes. The main problems with relying on indicators are:

- healthcare surveillance data represent only a small fraction of actual health impact
- most systems cannot identify small increases in cases
- it is not always clear when to look for chronic health effects or those with long latency due to wide window for clinical presentation
- population displacement distorts results
- measuring health outcomes and exposures at population level mean that individual associations between floods and health cannot be defined

Ideally, a longitudinal study following a cohort of individuals with detailed exposure assessment and health outcome measurements would be conducted to fully explain the impact of an individual flood. This is briefly mentioned in the following section and explored in more detail in a separate protocol for establishing a health register following a flood, developed for the PHASE project.

6.2 Health registers for floods

A health register is a rapid way to collate basic details of individuals affected, including their contact details, in the immediate aftermath of an event such as a flood. Epidemiological studies can then be planned and conducted using the individuals recruited onto the register to answer research questions. Particular benefits of this approach to gathering data include:

- data can be collected on all those affected, including physical, psychological and economic information, allowing linkages to be made between individual exposure and health outcomes
- contact and follow up of displaced persons and those who move away is improved
- long-term follow up to identify health effects and their time course is possible
- multiple health outcomes in the same individual can be identified, including any unknown health effects

A health register of individuals also provides data on population size, demographics and initial health impact to inform clinical, public health interventions and advice.

6.3 Conclusions

As with all public health tools, indicators using routine health data for floods must be constantly tested and refined. This is true of each indicator itself, but also of the entire suite, which can be modified according to which new datasets become available and what new research suggests.

The WHO report on flooding in Europe suggested that “a standard reporting system of health effects should be used in each flood event in order to build the evidence base on acute and chronic effects”.[1] It seems that, given the heterogeneity of floods and surveillance systems available, it would be more useful for each country to monitor the impact using indicators relevant to them, and share this intelligence across Europe to constantly improve the evidence and work towards a standardised system. The PHASE collaboration provides the opportunity to do this now and in the future.

To get a full picture of the “acute and chronic health effects of a flood, from the immediate response to completion of recovery”,[1] an in-depth longitudinal study developed from the health register could be useful. As part of the PHASE project, a protocol for establishing a health register after a flood has also been produced, which public health professionals could use to explore this further.

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Appendix 1: Evidence for health outcomes of flooding

Key
Green = injury/non-communicable disease; Blue = mental health outcomes; Pink = infectious disease; Yellow = Other health outcomes.

Timeframe post flood when the health outcome was studied is stated if available, otherwise the timeframe is assigned by WHO categories[39]: short-term - those happening during or immediately after flooding; mid-term - those developing in the days or early weeks following flooding; long-term - effects which may appear after and/or last for months or years.

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
Mortality - all cause	Direct: exposure to floodwater, collapsed buildings, fires, reconstruction indirect: flood-related stress, displacement / evacuation, exacerbation of chronic disease, interruption of care for existing disease	Hurricane Katrina, US, 2005[1,40]	Percentage of deaths in hurricane exposed population; count of deaths by cause	Records on dedicated emergency state department of health database for which the circumstances of death can be linked to hurricane included drowning, lack of necessary medical services, chronic conditions, stress-induced heart attacks or strokes, violence, and suicide NB many in population did not comply with evacuation order	1.2% overall mortality rate in the exposed population, “similar to that in other flood events” 771-1118 deaths (40% drowning, 25% injury, 11% heart conditions)	S
		Various floods, Europe[1]	Mean number of deaths per flood	Survey completed by governmental organisations across Europe. Deaths reported either via medical centres or directly to emergency response coordinators or police.	14 deaths	S
		Flash flood, Nîmes, France, 1988[11]	Count of deaths by ICD9: All cause, ischaemic cardiopathies, cerebrovascular accidents, drownings, deaths related to natural	Routine mortality data. Analysed data 21 months pre- and 3 months post-flood	9 deaths	M: 3 months post-flood

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
			disasters			
		319 floods from 1994–2005, England and Wales	Percentage change in mortality	Time-series analysis, based on postcodes linked to floods Routine mortality data	10% decrease in mortality in year post flood (n=693) compared to the year pre-flood (n=771) at same flooded postcodes	L: 12 months post-flood
		Bristol, UK, 1968[1]	Mortality rate in flood-affected community	Compared mortality rate between flooded and non-flooded community Routine mortality data	50% increase	L: 12 months post flood
Electrocution	Exposure to floodwater electricity, reconstruction	n/a		No evidence provided.	Stated as a risk, but no explicit studies or evidence presented in WHO report[1]	S
Hypothermia	Exposure to floodwater, loss of power	n/a		No evidence provided	Stated as a risk, but no explicit studies or evidence presented in WHO report[1]	S
Heart attacks	Flood-related stress, physical exertion during/after flood	Hurricane Katrina (Louisana), 2005[40]	Deaths from heart conditions	Routine mortality data Analysis of death certificates plus data on the Disaster Mortuary Operational Response Team confirmed victims' database	11% of all deaths (~108/986)	S, M, L
Smoke inhalation and burns	Flood-related fires	UK[41]	Incident	Incident report where fires started after 2007 floods, leading to evacuation	Stated as a risk, but no explicit studies or evidence presented in WHO report[1]	S
Injury/ physical trauma eg fractures, punctures, cuts	Exposure to floodwater, collapsed buildings, fires, reconstruction, loss of power leading to accidents	Flash flood, Nîmes, France, 1988[11]	Proportion of population reporting mild injuries (contusions, cuts and sprains)	Large community survey of 187 flooded households (108 responses), post flood	6% (n=108 households). 70% of these cases, had been sustained during the impact phase 3 severe injuries reported	S
Carbon monoxide poisoning	Loss of power leading to alternative, unsafe power sources; recovery work	England and Wales, 2007[1]	Count of deaths caused by carbon monoxide poisoning	Routine mortality data	2 deaths	S

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
	involving diesel/petrol driven devices	Four hurricanes in Florida in 2004; hurricane Rita, US[1]	Count of carbon monoxide poisoning cases attending hospital	Routine hospital admission data. Small sample size	6 deaths, 167 poisoning cases 5 deaths, 21 poisoning cases	S: 5 days post flood
Chemical exposure, eg pesticide, heavy metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons	Release or displacement of chemicals from agricultural, industrial, roadway or household chemicals by floodwater/floodwater damage	Hurricane Katrina, US, 2005[1]	Increase in calls to poisons centre	Routine data - calls to a poisons centre compared data for the preceding 3 years	13% increase in calls During the 0–2 weeks after hurricane, there was a significant increase in the number of calls about exposure to lamp oil, gasoline and carbon monoxide	M: 12 weeks postflood
Suicide	Bereavement, loss of possessions, loss of home, evacuation/ displacement, financial cost, disruption to normal life, recovery and reconstruction pressures etc	US, unknown location[39]	Suicide rate	Routine data – mortality data	Pre-flood (36m) rate: 12.1/100,000; Post flood (48m) rate 13.8/100,000; significant	M, L (48 months)
		Hurricane Katrina, US, 2005[1]	Count of suicide	Records on dedicated state department of health database for which the circumstances of death can be linked to hurricane	<10 cases	S
Agitated behaviour (violence/ threatening violence)		n/a		No evidence of increased risk, though adverse mental health known outcome	No evidence provided, but known to be a consequence of traumatic events[3]	L
Drug/alcohol intoxication or withdrawal		n/a		No evidence of increased risk, though adverse mental health known outcome	No evidence provided, but known to be a consequence of traumatic events[3] Anecdotal evidence of increased consumption after floods in England 2007[6]	S, M, L
Anxiety or stress		30 floods in England and Wales[1]	Proportion of people with General Health Questionnaire -12 scale indicative of mental health problems (>4)	Active surveillance - cohort study with questionnaire	2/3 victims mental health problems indicated	S, M, L

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
		England, 2007[42]	Self-reported anxiety using GAD-7 tool	Active surveillance: case control of flooded vs non-flooded households Limitations included poor response rate and non-representative age groups (→bias?)	OR = 4.8 for probable anxiety (95% CI 3.0, 7.8)	L: 3-8 months
Psychological distress		England, 2007[42]	Self-reported psychological stress using GHQ-12 tool	Active surveillance: case control of flooded vs non-flooded households Limitations include poor response rate and non-representative age groups (→bias?)	OR = 5.0 for psychological distress (95% CI 3.4, 7.3)	L: 3-8 months
		Lewes, UK 2000[1]	Self-reported psychological distress	Active surveillance. Cohort Children may be particularly vulnerable	4 times higher risk for psychological distress 9 months post	L: 9 months
Depression		Coastal flooding, France, 2010[21]	Prescription data for psychotropic drugs	Routine prescription data through health insurance Count of new patients receiving prescriptions in 3 weeks post flood compared to periods before and after	RR=1.53 (95%CI 1.39-1.61) of prescription of new antidepressant, tranquiliser and hypnotic treatments in the 21 day period post flood than other periods	S: 3 weeks
		US[1]	Self-reported symptoms of depression	Active surveillance Interviews No information about the respondents' psychosocial health before the disaster	45.5% of 457 dialysis patients reported symptoms of depression	
		England, 2007[42]	Self-reported symptoms of depression using PHQ-9 tool	Active surveillance - case control of flooded vs non-flooded households Limitations including poor response rate and non-representative age groups	OR = 2.6 for probable depression (95% CI 1.6, 4.3)	L: 3-8 months
Post-traumatic stress disorder (PTSD)		Various[3]	Prevalence of population with PTSD, as diagnosed with different criteria	Systematic review	3.6-50.5%. PTSD is sometimes considered to be the dominant post-disaster mental health condition	M, L
Gastroenteritis - specific microbes	Exposure to sewage in floodwater; consumption of poorly stored foodstuff due to loss of power; lack of clean water to maintain personal	Canada[2]	Outbreak	Outbreak investigation. Occurred several days after heavy rainfall, which was hypothesised as causative factor of the outbreak	*E. coli* O157:H7 and Campylobacter outbreak. No effect size provided	S (within 10 days)
		England and Wales, 1910 to 1999[4]	Outbreaks	Case-crossover study comparing rainfall in the 4 weeks before 89 drinking water outbreaks with 5 previous control years	Giardia, Cryptosporidium, *E. coli, Salmonella Typhi, Salmonella Paratyphi*, Campylobacter and *Streptobacillus moniliformis* outbreaks significantly associated with excess cumulative rainfall in the previous 7 days (p = 0.001)	

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
	hygiene or prepare foodstuff; contaminated drinking water supplies	Germany[2]	Outbreak	Outbreak investigation, linked to direct exposure with raw sewage-contaminated floodwater	Norovirus 26 ill in outbreak. 6/10 firefighters with floodwater contact also diarrhoea and vomiting	
Gastroenteritis symptoms	Exposure to sewage in floodwater; consumption of poorly stored foodstuff due to loss of power; lack of clean water to maintain personal hygiene or prepare foodstuff; contaminated drinking water supplies	Lewes, UK[2]	Association with depth of floodwater	Historical cohort study, post-flooding survey interview	Diarrhoea and vomiting RR=1.7 (95% CI 0.9–3.0) with depth of flooding	S
		US[2]		Active surveillance Cross-sectional survey. 1,110 individuals provided flood survey health data	House/yard flooding significantly associated with gastrointestinal illness (Incidence rate ratio = 2.36; 95% CI 1.37–4.07)	
		Canada[2]		Longitudinal study, association between extreme rainfall and spring snowmelt and waterborne disease outbreaks	For rainfall events greater than 93rd percentile, the relative odds of water-borne outbreak increased by 2.283 (95% CI 1.216, 4.285)	
		Italy, 1993-2010[2]		Routine data National statistics collected by Ministry of Health	"Some association" with: hepatitis A, salmonellosis, infectious diarrhoea, leptospirosis, cutaneous and visceral leishmaniasis, legionellosis	
		Hurricane Floyd, 1999[1,2]	Outpatient visits	Routine data – outpatient visits at health centres compared to non-flooded counties Investigation of pathogens and ill-defined intestinal infections	Increase *Toxoplasma gondii* ($p < 0.05$), adenoviruses ($p < 0.01$) of average < 1 extra outpatient visit per month per county Significant increase for ill-defined intestinal infections	
Soft-tissue infections (wounds)	Difficulty in accessing washing and/or medical facilities, contact with contaminated floodwater	Typhoon Haitang, Taiwan, 2005[1]	Incidence of lower-limb cellulitis	Active surveillance at hospital. Compared incidence pre and post flood	Some evidence of lower-limb celluliti,. RR 2.0 (95% CI, 1.4–2.6) (n=65), associated with immersing limb in floodwater	2 weeks post flood
		Hurricane Katrina, US, 2005[43]	Presence of disease	Outbreak reports	Evacuees and rescue workers. Wound infections with *Vibrio vulnificus* and *V. parahaemolyticus* (24 cases, 6 deaths); *Staphylococcus aureus* (30 patients) and *Tinea corporis* Toxic water contaminated areas led to skin infections, mostly in people who were immunocompromised[1])	3 weeks post flood

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
Leptospirosis	Altered pattern of human-rodent contact; contact with urine-contaminated floodwater	Italy, 2002[2]	Serologically confirmed cases leptospirosis	Active surveillance of flood-exposed population Population specific study: sero-epidemiogical (IgM antibodies) and micro-agglutination testsVerification of flood as risk factor not possible due to lack of control group	7/44 patients exposed to floodwaters had *Leptospira* antibodies and 5 confirmed positive. Re-testing months later 3 cases (6.8% seroconversion rate)	S
		Czech Republic, 1997 and 2002[2]	Serologically confirmed cases leptospirosis	Routine leptospirosis surveillance data Observed after 2 different flood events	Rates of serologically confirmed cases 3 times higher than normal (0.9 cases/100,000 inhabitants) 94 confirmed cases in 1997 and 92 confirmed cases in 2002. Two-thirds from inundation areas, half directly associated with floodwater[2]	
		France 2009[2]	Leptospirosis diagnosis	Longitudinal study of laboratory confirmed cases	Three cases identified after period of flooding/ heavy rainfall	
		Austria, 2010[2]	Leptospirosis diagnosis	Outbreak investigation Serologically confirmed	First documented outbreak of leptospirosis in Austria; 4 cases after swimming in open water after heavy rainfall	
		US, 2004[2,44]	Febrile illness	Outbreak investigation of flooded university Internet survey	Two confirmed cases 90/271 (33%) responders to survey reported febrile illness within 30d of floodwater contact	
Fungal infections	Living in mouldy buildings	US[45]	Incidence of invasive fungal infections related to floods	Literature review Recommendation that laboratory-based surveillance for mould-related illnesses that involve laboratory analyses	No reports of increased infections However, some rare but important diseases may occur: invasive fungal disease, blastomycosis, invasive aspergillosis, histoplasmosis, *Aspergillus preceptins*, zygomycosis and fusariosis	M-L (weeks to months, little data)
Respiratory symptoms, such as asthma, allergic rhinitis, allergic	Living in damp and/or buildings	Hurricanes Katrina and Rita, US, 2005[25]	Proportion with upper and lower respiratory tract symptoms	Active surveillance by surveying 600 randomly selected residential sites and then interviewing1 adult per site	65% upper respiratory tract symptoms (most nasal symptoms) 44% lower respiratory tract symptoms (most cough) Significant correlation with exposure Greater risk if exposed to flood-damaged home	M: 6-months post-flood

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
conjunctivitis, eczema, cough, wheeze, in chronic cases asthma and hypersensitivity pneumonitis, after exposure to moulds and spores		Hurricanes Katrina and Rita, US, 2005[45]	Living in mould-contaminated home	Home inspections Fungal genera found most commonly in moist building materials: Penicillium spp., Aspergillus spp. (*A. versicolor*), Acremonium spp., Phoma spp., Cladosporium spp., Chaetomium spp. and Stachybotrys spp.[1]	46% (>100,000) homes had some mould contamination approximately 17% (40,000 homes) had heavy mould contamination	
Mosquito-borne viruses	Increase in vectors due to change in breeding patterns; increased human-vector interaction due to loss of protective infrastructure / more time spent outdoors	Czech Republic[2]	Antibody detection	Routine data Active surveillance Specimens from residents in flooded area examined serologically for mosquito-borne viruses	Antibodies detected after flood for Tahyna, Sindbis and Batai viruses, among 150 of 497 residents, with activity only found for Tahyna virus Tahyna virus outbreaks associated with flooding in the Danube River system have also been documented[2]	M, L
Insect bites / stings	Increase in some insects due to change in breeding patterns; increased human-vector interaction due to loss of protective infrastructure / more time spent outdoors	Various[2]	Mosquito population density	No information provided	Various papers linking increase in mosquito population density post flooding	M
		Czech Republic, 2002[2]	Biting frequency	No information in original paper given	Mass mosquito breeding with biting frequency peaking at 70 bites per person per minute	
		n/a[1]	Wasp stings	No information given on how this was calculated	Increased risk stings	
Ad hoc consultations to healthcare facilities	Loss of power and medicines; evacuation and loss of medicines; loss of community care infrastructure	US[1]	Hospital admissions	No information given on how this was calculated.	Some evidence provided for increased hospital admissions of patients usually cared for in the community, such as for dialysis patients and people with cystic fibrosis	S
		Hurricane Katrina, US[1]	Hospital emergency department visits	Active surveillance Collected data from 8 hospitals and 21 healthcare facilities Does not say what the usual proportion of healthcare visits is	One week after hurricane, 21,673 ED visits: 7.2% prescriptions refill, 5.7% follow-up visits, 29.1% injuries, 58% for illness. Of all presentations, 14.1% were for a chronic disease or related condition, and the proportion of presentations for chronic disease	S: 7 days

Broad health outcome	Exposure / hazard	Event location, year	Indicator used	Source of data/study design	Main results	Time-frame (S, M, L)
					increased with age	
Disrupted healthcare appointments	Evacuation, disruption of routine, disruption of transport infrastructure	Hurricane Katrina, US[1]	Missed hospital outpatient appointments	Active surveillance Interviews	Post hurricane, 457 dialysis patients interviewed showed half missed one session and 16.8% missed three or more Various countries report disruption of routine healthcare appointments	S,M
Calls to ambulances	Drowning/injury, assisting at evacuation centres, transport services, primary care services	n/a[1]	Ambulance calls	Routine ambulance call data	No evidence provided, just state 'great demand'	S

Appendix 2: Developing a suite of indicators for identifying public health impact of flooding in England

Aim

To suggest a suite of indicators from existing surveillance systems that would establish if there are identifiable health impacts in the geographical areas affected by flooding in England.

Development of indicators

The indicators listed have been developed based on the evidence available for each health outcome's association with flooding (see Appendix 1 for evidence and references), with the data source being chosen according to the expected severity of the health outcome. For example, few cases of gastroenteritis are likely to require emergency hospital treatment, so hospital-based surveillance systems are unlikely to distinguish any statistically significant impact. The data sources included are those currently received directly by PHE via existing agreements with data providers, or openly accessible to professional groups via NHS portals.

Some of the indicators are well established and used routinely by PHE, whereas others are new. Effort has been made to suggest relevant codes or classifications to form part of the indicator based on published literature; however, there is a paucity of published studies for many health outcomes. Therefore, it is important that relevant experts are consulted (eg microbiologists, psychologists, medics) before defining the final indicator.

For the purposes of having a large enough sample size to detect a statistically significant change in health events at the population level, it is suggested that data should be gathered at the local authority level (upper or lower tier) for most indicators.

Analysis

The method for calculating if there is a statistically significant flood-related impact will vary by the indicator. Typically a calculation will be carried out to establish whether the observed count/rate of cases/reports is greater than the expected count/rate. This can be done by comparing indicator data during the flood with data for the same area at a time point prior to the flooding, or comparing data for the area flooded with an area unaffected by flooding during the same time period.

As most of the datasets suggested here are in regular use by PHE staff, analysis should be conducted by the data owners and providers (such as the Real-time Syndromic Surveillance Team, or Knowledge and Intelligence Team), who can advise on the best method of statistical analysis, comparison groups, as well as data caveats and baseline rates. All other indicators could be analysed by Field Epidemiology Services. Overall collation and reporting of data should be coordinated by Field Epidemiology Services with input from the Extreme Events and Health Protection Team and incident directors (local and national, if relevant). In large incidents, a Surveillance Cell may be set up as part of PHE's national incident co-ordination centre.

Identifying exposed populations

Flood data are available from different organisations in England at varying geographical resolution. Environment Agency can supply flood data via the PHE Extreme Events and Health Protection team; however, the accuracy available during the emergency phase is likely to be low and it is probable that flooding exposure for early health studies will be assigned at local authority level (upper or lower tier).

Evaluation and future work

This suggested suite of indicators requires piloting, evaluating and refining. Inevitably some indicators will be more useful than others and it is recognised that for some health outcomes, expected case numbers may be too low to be identifiable using routine data. In addition, the disease burden may be too small to warrant additional surveillance. However, by testing these indicators, either prospectively or retrospectively, a robust tool for analysing the health impact of floods can be developed.

PHE was created on 1 April 2013 and brings together a number of public health organisations, including the Health Protection Agency, public health observatories and disease registries. The full wealth of data currently available within PHE is being mapped by the Chief Knowledge Officer (CKO) directorate, which is committed to ensuring tools and datasets are available for public health professionals to use as evidence to improve health and wellbeing.[46] The suggested suite of indicators here should therefore be considered dynamic and should be periodically reviewed and updated.

In addition, the new potential data sources listed below are being explored by PHE teams.

Mental health indicators

The Real-time Syndromic Surveillance Team (ReSST) is exploring the possibility of using GP consultation data on anxiety, stress and other psychological conditions. In addition, the CKO Knowledge and Intelligence Team in north-east England is scoping a project with the University of Durham to develop a system for measuring mental illness in the community.

Helpline data

ReSST is developing a robust system for analysing NHS 111 (health phone line) data; the NHS 111 system is made up of several different data providers and replaces the previous national system of NHS Direct. This will provide early warning of community based symptoms.

Ambulance data

Use of ambulance call data is being explored. There are likely to be differences between ambulance services across England with differing clinical data systems, which require matching to provide a national picture of ambulance activity. Pilot investigations have shown significant increases in calls to London Ambulance Service during heatwaves and extreme cold weather, for example due to increased injuries.[14]

Code	Indicator title	Rationale	Definition	Data source	Comments
		Mortality			
MORT	Mortality	Many studies have been conducted into deaths relating to flooding, with direct deaths due to drowning, heart attacks and trauma having been reported. Studies conducted 12 months post flood using death registration data have shown that mortality may continue to be affected in the long term, for example as a consequence of other flood-related illnesses or ongoing stress from a delay in return to normality, although the effect size is highly variable. A complete set of death registrations in England, by registration date, is usually available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	All cause mortality	Office for National Statistics	Weekly raw data analysed by Respiratory Diseases Dept but a) unlikely to pick up small numbers b) registration of deaths related directly to floods will usually be delayed by coroners, so better to wait for full, detailed set One large study showed a decrease in mortality post flooding due to population displacement Could be repeated at different time periods post flood, eg 6, 12, 18 and 24 months
		Gastrointestinal conditions			
GI-HPZ	Gastroenteritis outbreak events	There is substantial evidence in the literature that flooding can lead to gastroenteric illness, with community surveys showing diarrhoea and vomiting being significantly associated with floodwater inundation of homes and reports of outbreaks occurring in Europe, such as with norovirus. However, there are also numerous reports showing no increase in gastrointestinal symptoms after flooding, and it is concluded to be an infrequent outcome in developed countries. Floodwater may be contaminated with sewage from wastewater overflows/septic tank inundation, or decaying carcasses. In addition, lack of access to power and clean water can result in inability to shower or flush toilets, or store and prepare food hygienically. Most illness would be expected to manifest within two weeks of exposure; the timeframe for surveillance activities would depend on what is known about exposure period (duration of floodwater exposure). PHE Centres are informed of public health events, including infectious disease outbreaks and non-infectious hazards, by organisations responding on scene and Centre staff often attend local emergency meetings during the flood. They may also be contacted by local health professionals and concerned members of the public for advice. This occurs in real time, and long-term health impact may also be reported, giving a good overview of what health impact is occurring in the community affected therefore and can be directly linked to the flood.	Gastroenteritis event directly linked to flood	PHE database: HPZone	Likely to only include more significant incidents such as those with acute health impact or significant releases

GI-GP	GP consultations for gastroenteritis syndromes	There is substantial evidence in the literature that flooding can lead to gastroenteric illness, with community surveys showing diarrhoea and vomiting being significantly associated with floodwater inundation of homes and reports of outbreaks occurring in Europe, such as with norovirus. However, there are also numerous reports showing no increase in gastrointestinal symptoms after flooding, and it is concluded to be an infrequent outcome in developed countries. Floodwater may be contaminated with sewage from wastewater overflows septic tank inundation, or decaying carcasses; in addition, lack of access to power and clean water can result in inability to shower or flush toilets, or store and prepare food hygienically. Most illness would be expected to manifest within two weeks of exposure; the timeframe for surveillance activities would depend on what is known about exposure period (duration of floodwater exposure). Syndromic surveillance of GP consultations provides near real-time data that can be used to assess levels of acute illness/disease in the community. The GP in hours and out of hours/unscheduled care systems complement one another and indicators are measured as weekly GP consultation/diagnosis rates per 100,000 population, for each syndrome.	Daily GP in/out of hours consultations for: • gastroenteritis • diarrhoea • vomiting Alarms based on rates seen in previous years at the same time of year for each PHEC and LA.	PHE syndromic surveillance data from the GP in hours syndromic surveillance system and GP out of hours/unscheduled care surveillance system	GP in hours and out of hours systems have coverage in approximately 60% and 80% of England respectively

GI-LAB	Laboratory diagnosed cases of gastrointestinal pathogens	There is substantial evidence that flooding can lead to gastroenteric illness, with community surveys showing diarrhoea and vomiting being significantly associated with floodwater inundation of homes and reports of outbreaks occurring in Europe, such as with norovirus. However, there are also numerous reports showing no increase in gastrointestinal symptoms after flooding, and it is concluded to be an infrequent outcome in developed countries. Floodwater may be contaminated with sewage from wastewater overflows/septic tank inundation, or decaying carcasses; in addition, lack of access to power and clean water can result in inability to shower or flush toilets, or store and prepare food hygienically. Most illness would be expected to manifest within two weeks of exposure; the timeframe for surveillance activities would depend on what is known about exposure period (duration of floodwater exposure). Clinically significant laboratory diagnoses are reported by nearly every laboratory in England to PHE on a daily basis, with 80-95% of laboratories reporting all infections within 21 days of the specimen date. This provides timely, near real-time, local information for situational awareness. Some microorganisms come under mandatory reporting according to PHE protocols. Studies in Europe have shown a significant association between flooding and the water-borne micro-organisms listed below. All but norovirus are mandatory to report to LabBase. Incubation periods: • *Salmonella* spp - 0.5-3 days • *E. coli* – 3-8 days • Campylobacter – 2-5 days (1 to 11 days) • Norovirus – 1-2 days • Cryptosporidium - 7-10 days (1-28 days) • Hepatitis A – 28 days (15–50 days)	Exceedance reports of gastrointestinal pathogens: • Salmonella spp • *E. coli* • Campylobacter • Norovirus • Cryptosporidium • Hepatitis A Reports are generated weekly where observed numbers are compared to expected, based on the surrounding weeks for the past few years at laboratory level	PHE LabBase – reports from diagnosing laboratories	All NHS and most private laboratories in England Most provided with full GP postcode, often also has full patient postcode

GI-EDSSS	Emergency department consultations for gastrointestinal syndromes	There is substantial evidence in the literature that flooding can lead to gastroenteric illness, with community surveys showing diarrhoea and vomiting being significantly associated with floodwater inundation of homes and reports of outbreaks occurring in Europe, such as with norovirus. However, there are also numerous reports showing no increase in gastrointestinal symptoms after flooding, and it is concluded to be an infrequent outcome in developed countries. Floodwater may be contaminated with sewage from wastewater overflows/septic tank inundation, or decaying carcasses; in addition, lack of access to power and clean water can result in inability to shower or flush toilets, or store and prepare food hygienically. Most illness would be expected to manifest within two weeks of exposure; the timeframe for surveillance activities would depend on what is known about exposure period (duration of floodwater exposure). Syndromic surveillance of hospital emergency department attendances including diagnoses, investigation, treatments and discharge (ie final outcomes) provides real time data of severe disease.	Weekly count for: • all gastrointestinal illness • gastroenteritis • diarrhoea • vomiting Statistical alarms generated if activity rises significantly compared to past two weeks	PHE data from the Emergency Department Syndromic Surveillance System	Sentinel system across England; nearly all PHE regions have a reporting hospital Ability to analyse data by postcode district
Respiratory conditions					
RSP-HPZ	Respiratory symptom events	Living in damp and mouldy properties can lead to exacerbation of asthma symptoms, cough, allergic rhinitis and other upper and lower respiratory tract symptoms. Evidence shows that post flooding, a substantial proportion of properties may develop mould, which begins to grow within 48h. Symptoms occur when inhaling large quantities of mould spores but rate of growth depends on many factors;. In addition, susceptibility varies greatly between individuals. The potential window for clinical presentation is therefore difficult to calculate, but a community survey in New Orleans suggested that by 6 months post flood many had already experienced symptoms. PHE Centres are informed of public health events, including infectious disease outbreaks and non-infectious hazards, by organisations responding on scene and Centre staff often attend local emergency meetings during the flood. They may also be contacted by local health professionals and concerned members of the public for advice. This occurs in real-time and long-term health impact may also be reported, giving a good overview of what health impact is occurring in the community affected therefore and can be directly linked to the flood.	Respiratory symptom event directly linked to flood	PHE database: HPZone	Unclear / varying time frame / latency when mould/damp-related illness manifests Likely to only include more significant incidents such as those with acute health impact or significant mould

RSP-PRSC	Prescriptions for respiratory complaints	Living in damp and mouldy properties can lead to exacerbation of asthma symptoms, cough, allergic rhinitis and other upper and lower respiratory tract symptoms. Evidence shows that post flooding, a substantial proportion of properties may develop mould, which begins to grow within 48h. Symptoms occur when inhaling large quantities of mould spores but rate of growth depends on many factors; in addition, susceptibility varies greatly between individuals. The potential window for clinical presentation is therefore difficult to calculate, but a community survey in New Orleans suggested that by 6 months postflood many had already experienced symptoms. Prescriptions prescribed by family doctors, nurses, pharmacists and others indicate illness in the community. Data are aggregated into quarters (3 months) at the level of clinical commissioning groups, making this data source useful for measuring diseases that may have a wider timeframe for clinical presentation and understanding the wider epidemiology of the flood. Medicines are classified into *chapters* and *sections* according to the British National Formulary.	Prescriptions for drugs relevant to respiratory complaints, according to BNF, such as: • cough preparations • *others*	CCG Prescribing data available via iView from the Health and Social Care Information Centre: NHS Prescription Services	Data available approx 1-2 months after end each quarter Data come with associated cost of medicine, providing opportunity for quantifying cost economically Unclear / varying time frame / latency when mould/damp-related. Could repeat analysis at different time periods post-flood, eg quarterly for 12 months Data are available combined into quarters, but as timeframe for presentation is wide, this is unlikely to be a problem
RSP-GP	GP consultations for respiratory syndromes	Living in damp and mouldy properties can lead to exacerbation of asthma symptoms, cough, allergic rhinitis and other upper and lower respiratory tract symptoms. Evidence shows that post flooding, a substantial proportion of properties may develop mould, which begins to grow within 48h. Symptoms occur when inhaling large quantities of mould spores but rate of growth depends on many factors. In addition, susceptibility varies greatly between individuals. The potential window for clinical presentation is therefore difficult to calculate, but a community survey in New Orleans suggested that by 6 months post flood many had already experienced symptoms. Syndromic surveillance of GP consultations provides near real ime data that can be used to assess levels of acute illness/disease in the community. The GP in hours and out of hours/unscheduled care systems complement one another and indicators are measured as weekly GP consultation/diagnosis rates per 100,000 population, for each syndrome.	Daily GP in/out of hours consultations for: • upper respiratory tract infections • lower respiratory tract infections • allergic rhinitis • asthma • wheeze/breathlessnes s • difficulty breathing Statistical alarms based on rates seen in previous years at the same time of year for each PHEC and LA	PHE syndromic surveillance data from the 'GP in hours syndromic surveillance system' and' GP out of hours/unschedu led care surveillance system'	GP in hours and out of hours systems have coverage in approximately 60% and 80% of England respectively Local authority or health protection team resolution Unclear/varying time frame/latency when mould/damp related

RSP-EDSSS	Emergency department consultations for respiratory syndromes	Living in damp and mouldy properties can lead to exacerbation of asthma symptoms, cough, allergic rhinitis, and other upper and lower respiratory tract symptoms. Evidence shows that post flooding, a substantial proportion of properties may develop mould, which begins to grow within 48h. Symptoms occur when inhaling large quantities of mould spores but rate of growth depends on many factors; in addition, susceptibility varies greatly between individuals. The potential window for clinical presentation is therefore difficult to calculate, but a community survey in New Orleans suggested that by 6 months post flood many had already experienced symptoms. Syndromic surveillance of hospital emergency department attendances including diagnoses, investigations, treatments and discharge (ie final outcomes), provides real time data of severe disease.	Weekly count for: • acute respiratory infection • upper respiratory tract infection • respiratory tract infection • asthma • severe asthma Statistical alarms generated if activity rises significantly compared to past two weeks	PHE data from the Emergency Department Syndromic Surveillance System	Sentinel system across England; nearly all PHE regions have a reporting hospital Ability to analyse data by postcode district Unclear/varying timeframe/latency when mould/damp-related
RSP-HESED	Emergency department diagnosis of respiratory conditions	Living in damp and mouldy properties can lead to exacerbation of asthma symptoms, cough, allergic rhinitis and other upper and lower respiratory tract symptoms. Evidence shows that post flooding, a substantial proportion of properties may develop mould, which begins to grow within 48h. Symptoms occur when inhaling large quantities of mould spores but rate of growth depends on many factors; in addition, susceptibility varies greatly between individuals. The potential window for clinical presentation is therefore difficult to calculate, but a community survey in New Orleans suggested that by 6 months post flood many had already experienced symptoms. Acute hospital trusts provide records of all hospital emergency department attendances, representing severe disease. These contain the reason for the attendance (such as 'road traffic accident' or 'other accident'), and a description based on diagnosis (such as contusion, electric shock, respiratory condition). Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	A&E diagnosis 2/3 character: • 251 = respiratory conditions - bronchial asthma	Hospital Episode Statistics – Accident and Emergency Data	Unclear / varying time frame / latency when mould/damp-related. Could repeat analysis at different time periods post-flood, eg quarterly for 12 months

RSP-HESICD	Hospital admission and appointments for respiratory conditions or mycoses	Living in damp and mouldy properties can lead to exacerbation of asthma symptoms, cough, allergic rhinitis and other upper and lower respiratory tract symptoms. Evidence shows that post-flooding, a substantial proportion of properties may develop mould, which begins to grow within 48h. Symptoms occur when inhaling large quantities of mould spores but rate of growth depends on many factors; in addition, susceptibility varies greatly between individuals. The potential window for clinical presentation is therefore difficult to calculate, but a community survey in New Orleans suggested that by 6 months post-flood many had already experienced symptoms. Invasive mycoses infections are rare and have not been reported in association with flooding. Acute hospital and mental health trusts provide records of hospital admissions (inpatients) and outpatient appointments by ICD-10 code, representing more severe disease requiring specialist treatment. Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	Based on ICD-10 codes. Diag_code 1-20: • J45 Asthma • R05 Cough • B35-B49 Mycoses	Hospital Episode Statistics – Inpatient and outpatient data	Unclear / varying time frame / latency when mould/damp-related. Could repeat analysis at different time periods post-flood, eg quarterly for 12 months There is no data on mycoses infections and flooding / damp, but it is a plausible outcome so may be useful to explore There are 20 diagnosis codes, with *diag_1* representing primary diagnosis and _2-20 containing secondary/ subsidiary diagnoses. Requires careful analysis to link to flood. Cause code X38 = Victim of flood
Zoonotic conditions					
LEPT-LAB	Leptospirosis case	Leptospirosis is a zoonosis and although more common in tropical countries, can occur rarely in England where there are around 50-60 cases per year. Infection is usually through direct contact with animal urine, but can also occur via water contaminated with infected animal urine. Exposure to floodwater has been associated with leptospirosis in various countries in Europe. Symptoms usually develop 7-21 days after initial infection. Laboratory diagnosis of a new case of leptospirosis is mandatory to report to PHE. Laboratory diagnoses are reported by nearly every laboratory in England to PHE on a daily basis, with 80-95% of laboratories reporting all infections within 21 days of the specimen date. This provides timely, near real-time, local information for situational awareness. Cases of leptospirosis reported to PHE will be followed up by the health protection team to understand where it was acquired, therefore the association with floodwater can be verified.	New case of leptospirosis diagnosed in the 4 weeks post-flooding, and upon follow up found to be associated with floodwater exposure	PHE LabBase – reports from diagnosing laboratories	

Cardiovascular conditions					
CARD-EDSSS	Emergency department consultations for cardiovascular syndromes	Flooding can be demanding both physically for example through lifting heavy objects, and emotionally, as people cope with displacement and destruction caused by floodwater. There is some evidence that flooding is linked to morbidity and mortality from heart conditions; 11% of deaths in Louisiana after Hurricane Katrina were due to heart conditions. The long-term impact of flooding on cardiovascular health is not well understood. Syndromic surveillance of hospital emergency department attendances including diagnoses, investigation, treatments and discharge (ie final outcomes), provides real-time data of severe disease.	Weekly count for: • all cardiac • myocardial infarction Statistical alarms generated if activity rises significantly compared to past two weeks	PHE data from the Emergency Department Syndromic Surveillance System	Unclear / varying time frame / latency Effect size not well studied; useful to explore Sentinel system across England; nearly all regions have a reporting hospital Ability to analyse data by postcode district
CARD -HESED	Emergency department diagnosis of cardiac conditions	Flooding can be demanding both physically for example through lifting heavy objects, and emotionally, as people cope with displacement and destruction caused by floodwater. There is some evidence that flooding is linked to morbidity and mortality from heart conditions; 11% of deaths in Louisiana after Hurricane Katrina were due to heart conditions. The long-term impact of flooding on cardiovascular health is not well understood. Acute hospital trusts provide records of all hospital emergency department attendances, representing severe disease. These contain the reason for the attendance (such as 'road traffic accident' or 'other accident'), and a description based on diagnosis (such as contusion, electric shock, respiratory condition). Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	A&E diagnosis 2/3 character: • 201 = Cardiac conditions - myocardial ischaemia & infarction • 202 = Cardiac conditions - other non-ischaemia	Hospital Episode Statistics – Accident and Emergency Data	Unclear/varying time frame/latency Effect size not well studied; useful to explore
CARD-HESICD	Hospital admission and appointments for cardiovascular conditions	Flooding can be demanding both physically for example through lifting heavy objects, and emotionally, as people cope with displacement and destruction caused by floodwater. There is some evidence that flooding is linked to morbidity and mortality from heart conditions; 11% of deaths in Louisiana after Hurricane Katrina were due to heart conditions. The long-term impact of flooding on cardiovascular health is not well understood. Acute hospital and mental health trusts provide records of hospital admissions (inpatients) and outpatient appointments by ICD-10 code, representing more severe disease requiring specialist treatment. Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	Based on ICD-10 codes. Diag_code 1-20: • I20-I25 Ischaemic heart diseases • I60-I69 Cerebrovascular diseases	Hospital Episode Statistics – Inpatient and outpatient data	Unclear / varying time frame / latency Effect size not well studied; useful to explore There are 20 diagnosis codes, with *diag_1* representing primary diagnosis and _2-20 containing secondary/ subsidiary diagnoses. Requires careful analysis to link to flood. Cause code X38 = Victim of flood

Skin conditions					
SKN-PRSC	Prescriptions for dermal complaints	Wounds submerged in floodwater have the potential to become infected. There is limited evidence that this occurs in Europe, although one study in the US reported an outbreak of skin infections with *Staphylococcus aureus*. Most skin complaints would be expected within 14 days of the flood. Prescriptions prescribed by family doctors, nurses, pharmacists and others indicate illness in the community. Data are aggregated into quarters (3 months) at the level of clinical commissioning groups, making this data source useful for measuring diseases that may have a wider timeframe for clinical presentation and understanding the wider epidemiology of the flood. Medicines are classified into *chapters* and *sections* according to the British National Formulary.	Count of prescriptions for drugs relevant to dermal complaints, according to BNF, such as: • anti-infective skin preparations • others	CCG Prescribing data available via iView from the Health and Social Care Information Centre: NHS Prescription Services	There is very limited evidence from Europe/North America; worth exploring Data available approx 1-2 months after end each quarter Data come with associated cost of medicine, providing opportunity for quantifying cost economically Data are available combined into quarters, so this may not be useful for identifying a peak within 14 days
SKN-LAB	Laboratory confirmed skin infections	Wounds submerged in floodwater have the potential to become infected. There is limited evidence that this occurs in Europe, although one study in the US reported an outbreak of skin infections with *Staphylococcus aureus*. Most skin complaints would be expected within 14 days of the flood. Clinically significant laboratory diagnoses are reported by nearly every laboratory in England to PHE on a daily basis, with 80-95% of laboratories reporting all infections within 21 days of the specimen date. This provides timely, near real-time, local information for situational awareness. Some microorganisms come under mandatory reporting according to PHE protocols.	Any clinically significant infection where: • Specimen site = SKIN.	PHE LabBase – reports from diagnosing laboratories	There is very limited evidence from Europe/North America; worth exploring Reports not usually generated on Specimen site = skin, as it is not usually a sterile site, so data may not be complete. Worth exploring
SKN-GP	GP consultations for dermal syndromes	Wounds submerged in floodwater have the potential to become infected. There is limited evidence that this occurs in Europe, although one study in the US reported an outbreak of skin infections with *Staphylococcus aureus*. Contamination of water with irritant chemicals may also lead to skin rash or irritation. Skin complaints would be expected within 14 days of the flood. Syndromic surveillance of GP consultations provides near real-time data that can be used to assess levels of acute illness/disease in the community. The GP in hours and out of hours/unscheduled care systems complement one another and indicators are measured as weekly GP consultation/diagnosis rates per 100,000 population, for each syndrome.	Daily GP in/out of hours consultations for: • cellulitis • rash Statistical alarms based on rates seen in previous years at the same time of year for each PHEC and LA	PHE syndromic surveillance data from the GP in hours syndromic surveillance system and GP out of hours/unscheduled care surveillance system	There is very limited evidence from Europe/North America; worth exploring GP in hours and out of hours systems have coverage in approximately 40% and 60% of England respectively

SKN-EDSSS	Emergency department consultations for allergic skin reaction syndromes	Wounds submerged in floodwater have the potential to become infected. There is limited evidence that this occurs in Europe, although one study in the US reported an outbreak of skin infections with *Staphylococcus aureus*. Contamination of water with irritant chemicals may also lead to skin rash or irritation. Skin complaints would be expected within 14 days of the flood. Syndromic surveillance of hospital emergency department attendances including diagnoses, investigation, treatments and discharge (ie final outcomes), providing real-time data of severe disease	Weekly count for: • all allergic skin reactions Statistical alarms generated if activity rises significantly compared to past two weeks	PHE data from the Emergency Department Syndromic Surveillance System	There is very limited evidence from Europe/North America; worth exploring Sentinel system across England; nearly all regions have a reporting hospital Ability to analyse data by postcode district
SKN-HESED	Emergency department diagnosis of soft tissue inflammation	Wounds submerged in floodwater have the potential to become infected. There is limited evidence that this occurs in Europe, although one study in the US reported an outbreak of skin infections with *Staphylococcus aureus*. Contamination of water with irritant chemicals may also lead to skin rash or irritation. Skin complaints would be expected within 14 days of the flood. Acute hospital trusts provide records of all hospital emergency department attendances, representing severe disease. These contain the reason for the attendance (such as 'road traffic accident' or 'other accident'), and a description based on diagnosis (such as contusion, electric shock, respiratory condition). Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	A&E diagnosis 2/3 character: • 03 = Soft tissue inflammation	Hospital Episode Statistics – Accident and Emergency Data	There is very limited evidence from Europe/North America; worth exploring
SKN-HESICD	Hospital admission and appointments for cellulitis	Wounds submerged in floodwater have the potential to become infected. There is limited evidence that this occurs in Europe, although one study in the US reported an outbreak of skin infections with *Staphylococcus aureus*. Contamination of water with irritant chemicals may also lead to skin rash or irritation. Skin complaints would be expected within 14 days of the flood. Acute hospital and mental health trusts provide records of hospital admissions (inpatients) and outpatient appointments by ICD-10 code, representing more severe disease requiring specialist treatment. Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	Based on ICD-10 codes. Diag_code 1-20: • L03 Cellulitis	Hospital Episode Statistics – Inpatient and outpatient data	There is very limited evidence from Europe/North America; worth exploring There are 20 diagnosis codes, with *diag_1* representing primary diagnosis and _2-20 containing secondary/ subsidiary diagnoses. Requires careful analysis to link to flood. Cause code X38 = Victim of flood

Chemical exposure and poisonings					
CHEM-UKPID	Poisons centre enquiries for environmental chemical poisonings	Household, commercial, industrial and agricultural chemicals may become displaced and mobilised by floodwater. Although environmental sampling has provided some evidence of chemical contamination of soils and properties post-flooding, there is little evidence of any adverse health effects via this route. Carbon monoxide (CO) poisoning and deaths, however, are a well-established consequence of flooding. CO can be produced where petrol/diesel-powered appliances are used for drying, heating or DIY, or camping stoves or BBQs for cooking, indoors or near air intakes. Evidence from the US shows that poisoning calls from members of the public increase post-flooding, regarding CO poisoning and also exposure to fuels (propane, kerosene). Chemical exposure may also occur during clean-up operations, such as accidental exposure to household chemicals. Finally, floods can cause fires, so smoke inhalation is a possible health impact. Most poisonings occur within 14 days of the flood. All enquiries (both web and telephone) from clinical professionals regarding poisoned patients are dealt with by toxicology experts at the National Poisons Information Service and captured on a database. These data represent real-time, severe poisoning data.	Poisoning enquiries in flood-affected areas (regions / hospitals / GP surgery), relating to: • all causes • carbon monoxide • domestic heating oil • petrol • household cleaning products	National Poisons Information Centre's UK Poisons Information Database	Apart from CO, unclear if there would be a considerable increase in enquiries, as the only evidence available from US shows calls are from public, whereas UK system records enquiries from professionals Collects data on caller by hospital / GP surgery, and therefore can be analysed by geographical unit
CHEM-CRCE	Chemical incidents	Household, commercial, industrial and agricultural chemicals may become displaced and mobilised by floodwater. Although environmental sampling has provided some evidence of chemical contamination of soils and properties post-flooding, there is little evidence of any adverse health effects via this route. Carbon monoxide (CO) poisoning and deaths, however, are a well-established consequence of flooding. CO can be produced where petrol/diesel-powered appliances are used for drying, heating or DIY, or camping stoves or BBQs for cooking, indoors or near air intakes. Evidence from the US shows that poisoning calls from members of the public increase post-flooding, regarding CO poisoning and also exposure to fuels (propane, kerosene). Chemical exposure may also occur during clean-up operations, such as accidental exposure to household chemicals. Finally, floods can cause fires, so smoke inhalation is a possible health impact. Most poisonings occur within 14 days of the flood. Incidents and events involving potentially hazard substances into the environment are reported to PHE by emergency services, Environment Agency, local authorities, medical staff and members of the public. This occurs in real-time or in the recent aftermath of the flood. Information gathered includes actual or potential exposure to the hazard and any health impact and can be directly linked to the flood.	Chemical incident involving actual or potential exposure of members of the public, with or without symptoms	PHE Centre for Radiation, Chemical and Environmental Hazards *Ciris* database	Likely to only include more significant incidents such as those with acute health impact or significant releases

CHEM-HESED	Emergency department diagnosis of chemical exposure	Household, commercial, industrial and agricultural chemicals may become displaced and mobilised by floodwater. Although environmental sampling has provided some evidence of chemical contamination of soils and properties post-flooding, there is little evidence of any adverse health effects via this route. Carbon monoxide (CO) poisoning and deaths, however, are a well-established consequence of flooding. CO can be produced where petrol/diesel-powered appliances are used for drying, heating or DIY, or camping stoves or BBQs for cooking, indoors or near air intakes. Evidence from the US shows that poisoning calls from members of the public increase post-flooding, regarding CO poisoning and also exposure to fuels (propane, kerosene). Chemical exposure may also occur during clean-up operations, such as accidental exposure to household chemicals. Finally, floods can cause fires, so smoke inhalation is a possible health impact. Most poisonings occur within 14 days of the flood. Acute hospital trusts provide records of all hospital emergency department attendances, representing severe disease. These contain a description based on diagnosis and raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	A&E diagnosis 2/3 character: • 103 = Burns and scalds – chemical • 144 = Poisoning (inc overdose) - other, inc alcohol	Hospital Episode Statistics – Accident and Emergency Data	Unclear evidence about how common chemical exposure is, especially for non-CO. This would therefore be a useful indicator to explore
CHEM-HESICD	Hospital admission and appointments for chemical exposure	Household, commercial, industrial and agricultural chemicals may become displaced and mobilised by floodwater. Although environmental sampling has provided some evidence of chemical contamination of soils and properties post-flooding, there is little evidence of any adverse health effects via this route. Carbon monoxide (CO) poisoning and deaths, however, are a well-established consequence of flooding. CO can be produced where petrol/diesel-powered appliances are used for drying, heating or DIY, or camping stoves or BBQs for cooking, indoors or near air intakes. Evidence from the US shows that poisoning calls from members of the public increase post-flooding, regarding CO poisoning and also exposure to fuels (propane, kerosene). Chemical exposure may also occur during clean-up operations, such as accidental exposure to household chemicals. Finally, floods can cause fires, so smoke inhalation is a possible health impact. Most poisonings occur within 14 days of the flood. Acute hospital and mental health trusts provide records of hospital admissions (inpatients) and outpatient appointments by ICD-10 code, representing more severe disease requiring specialist treatment. Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	Based on ICD-10 codes. Diag_code 1-20: • T52-65 Toxic effects of substances chiefly non-medicinal as to source • X46 Accidental poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours • X48 Accidental poisoning by and exposure to pesticides • X49 Accidental poisoning by and exposure to other and unspecified chemicals and noxious substances	Hospital Episode Statistics - Inpatient and outpatient data	Unclear evidence about how common chemical exposure is, especially for non-CO. This would therefore be a useful indicator to explore There are 20 diagnosis codes, with *diag_1* representing primary diagnosis and _2-20 containing secondary/ subsidiary diagnoses. Requires careful analysis to link to flood. Cause code X38 = Victim of flood

Mental health conditions					
MENT-PRSC	Prescriptions for mental health complaints symptoms	Mental health conditions are known to be an important sequelae of flooding, with a number of studies showing effects such as stress, anxiety, depression in the short, medium and long-term. Other studies have suggested behavioural changes and substance abuse. Risk factors for these for example include loss of home, loss of belongings, dealing with rebuilding, financial concerns and dealing with insurance companies. Medication prescribed by family doctors, nurses, pharmacists and others indicate illness in the community. Data are aggregated into quarters (3 months) at the level of clinical commissioning groups, making this data source useful for measuring diseases that may have a wider timeframe for clinical presentation and understanding the wider epidemiology of the flood. Medicines are classified into *chapters* and *sections* according to the British National Formulary.	Count of prescriptions for drugs relevant to mental health complaints, according to BNF, such as: • antidepressant drugs • hypnotics and anxiolytics • others	CCG Prescribing data available via iView from the Health and Social Care Information Centre: NHS Prescription Services	Unclear / varying time frame / latency. Could be repeated at different time periods post-flood, eg quarterly for 2 years Data are available combined into quarters, but as timeframe for presentation is wide, this is unlikely to be a problem Data available approx 1-2 months after end each quarter Data come with associated cost of medicine, providing opportunity for quantifying cost economically
MENT-HESICD	Hospital admission and appointments for mental health conditions	Mental health conditions are known to be an important sequelae of flooding, with a number of studies showing effects such as stress, anxiety, depression in the short, medium and long-term. Other studies have suggested behavioural changes and substance abuse. Risk factors for these for example include loss of home, loss of belongings, dealing with rebuilding, financial concerns and dealing with insurance companies. Acute hospital and mental health trusts provide records of hospital admissions (inpatients) and outpatient appointments by ICD-10 code, representing more severe disease requiring specialist treatment. Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	Based on ICD-10 codes. Diag_code 1-20: • X60-X84 Intentional self-harm • F43 Reaction to severe stress, and adjustment disorders • F43.1 Post-traumatic stress disorder • F41.1 Generalised anxiety disorder • F41.2 Mixed anxiety and depressive disorder • F32 Depressive episode • F33 Recurrent depressive disorder	Hospital episode statistics – inpatient and outpatient data	Unclear/varying time frame/latency. Could be repeated at different time periods post flood, eg quarterly for 2 years Preliminary data available approx 3 months later There are 20 diagnosis codes, with diag_1 representing primary diagnosis and _2-20 containing secondary/subsidiary diagnoses. Requires careful analysis to link to flood. Cause code X38 = Victim of flood

Injuries					
INJ- EDSSS	Emergency department consultations for injuries and exposure to cold	Both fatal and non-fatal injuries have been reported in association with flooding. These include: • cuts, falls and muscular injuries associated with moving belongings before, during and after the flood, being hit with blunt objects through damaged buildings, reconstruction work • drowning during the flood • electrocution during and post flood • hypothermia Little evidence is available from routine health statistics on these health effects. However, there is evidence from community surveys, indicating that most injuries are mild and can be treated in the community. Syndromic surveillance of hospital emergency department attendances including diagnoses, investigation, treatments and discharge (ie final outcomes), providing real-time data on severe disease	Weekly count for: • all fractures • hypothermia • impact of cold Statistical alarms generated if activity rises significantly compared to past two weeks	PHE data from the Emergency Department Syndromic Surveillance System	Sentinel system across England; nearly all regions have a reporting hospital Ability to analyse data by postcode district
INJ-HESED	Emergency department diagnosis of injury	Both fatal and non-fatal injuries have been reported in association with flooding. These include: • cuts, falls and muscular injuries associated with moving belongings before, during and after the flood, being hit with blunt objects through damaged buildings, reconstruction work • drowning during the flood • electrocution during and post flood • hypothermia Little evidence is available from routine health statistics on these health effects. However, there is evidence from community surveys, indicating that most injuries are mild and can be treated in the community. Acute hospital trusts provide records of all hospital emergency department attendances, representing severe disease. These contain the reason for the attendance (such as ‘road traffic accident’ or ‘other accident’), and a description based on diagnosis (such as contusion, electric shock, respiratory condition). Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	A&E diagnosis 2/3 character: • 01 = laceration • 021 = contusion • 022 = abrasion • 03 = soft tissue inflammation • 041 = concussion • 042 = other head injury • 051 = dislocation • 052 = open fracture • 053 = closed fracture • 101 = burns and scalds – electric • 11 = electric shock • 15 = near drowning	Hospital Episode Statistics – Accident and Emergency Data	

INJ-HESICD	Hospital admission and appointments for injuries and exposure to cold	Both fatal and non-fatal injuries have been reported in association with flooding. These include: • cuts, falls and muscular injuries associated with moving belongings before, during and after the flood, being hit with blunt objects through damaged buildings, reconstruction work • drowning during the flood • electrocution during and post flood • hypothermia Little evidence is available from routine health statistics on these health effects. However, there is evidence from community surveys, indicating that most injuries are mild and can be treated in the community. Acute hospital and mental health trusts provide records of hospital admissions (inpatients) and outpatient appointments by ICD-10 code, representing more severe disease requiring specialist treatment. Raw data are available after approximately 3 months, whereas cleaned data are available after 12 months, making these routine data useful for understanding the wider epidemiology of the flood.	Based on ICD-10 codes. Diag_code 1-20: • S00-S99 = injuries • T00-T07 = injuries involving multiple body regions • T08-T14 = injuries to unspecified part of trunk, limb or body region • T75.1 = drowning and nonfatal submersion • T75.4 = effects of electric current • W86 = exposure to other specified electric current • W87 = exposure to unspecified electric current • T68 = hypothermia • X31 = exposure to excessive natural cold	Hospital Episode Statistics – Inpatient and Outpatient data	There are 20 diagnosis codes, with *diag_1* representing primary diagnosis and _2-20 containing secondary/subsidiary diagnoses. Requires careful analysis to link to flood. Cause code X38 = victim of flood