Public Health England

Beyond aberration detection,

- coping with multiple exceedances in a national syndromic surveillance service

ISDS Webinar, October 2016

Public Health England

Biography

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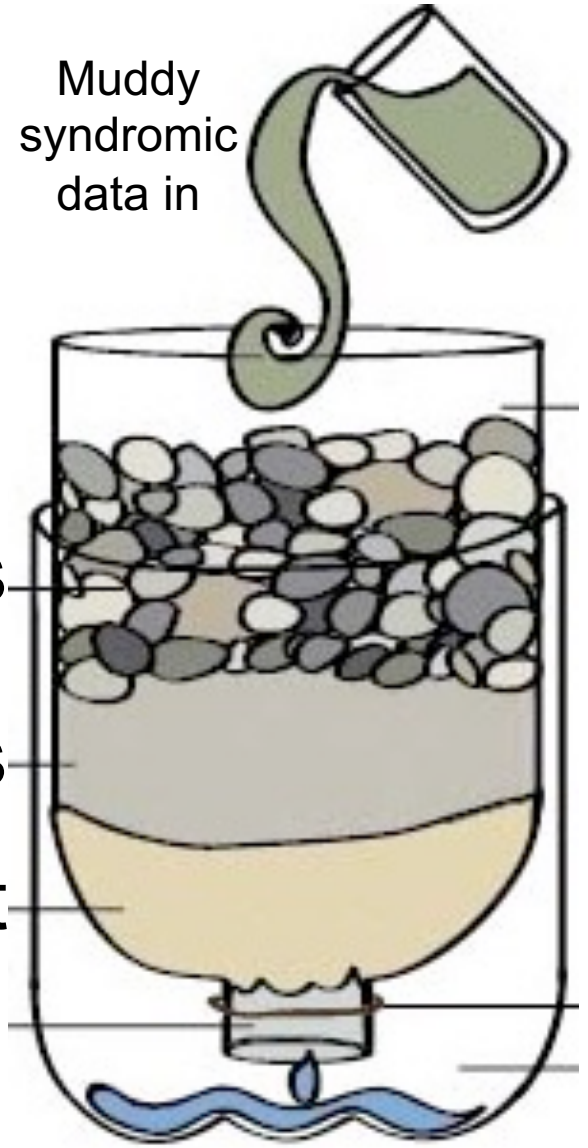
Overview

Aberration detection methods

Priority rules

Risk assessment



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Overview – a typical Monday

1. Data arrives
2. Aggregation into syndromic ‘signals’
3. Data quality checks
4. Automated aberration detection
5. Prioritisation of statistical alarms
6. Risk Assessment part I – How unusual is it?
7. Risk Assessment part II – What does it mean?
8. Outputs

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0. Where does the data come from?

1,000,000

patients visited a participating **GP** on Friday

109,000

patients contacted an **out-of-hours GP** (Fri-Sun)

22,000

patients attended 34 participating **EDs** (Fri-Sun)

108,000

people called **NHS111** (Fri-Sun)

GP = Family doctor (called General Practitioner in the UK)

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1. Data collection

Automated feeds of anonymised data to a secure server

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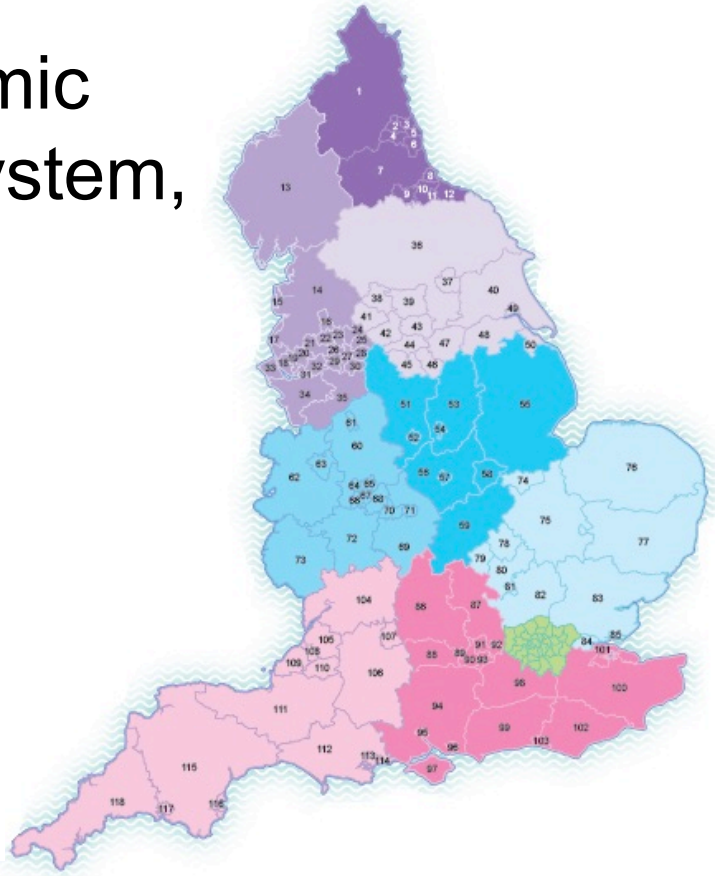
2. Aggregation into syndromic ‘signals’

“Signal” – a measure of syndromic activity which has a specified system, syndrome and geography.



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Aberration detection model

Model created for each signal
Refit every eight weeks

Multi-level mixed effects Poisson Regression model
Total consultations used as an offset

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Aberration detection model

$$\log(\mu_{ijk}) = \log(total_{ijk}) + \beta_0 + \beta_1 X_{ijk} + u_k + v_{jk}$$

For PHE Centre k, location j on day i.
Total is an offset based on total activity or population coverage
$\beta_1 X_{ijk}$ represents a vector for all the dependent variable coefficients,
u_k represents the PHE Centre level specific random effect
v_{jk} represents the specific random error for each local area within a PHE Centre

Uses all available historic data

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Aberration detection model

Independent variables included in model:

Day of the week
Month
Public holidays
System specific variables representing large changes
e.g. change in coding practice or introduction of rotavirus vaccine in July 2013

All independent variables are “predictable”

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Aberration detection model

Any questions before going on to priority rules?

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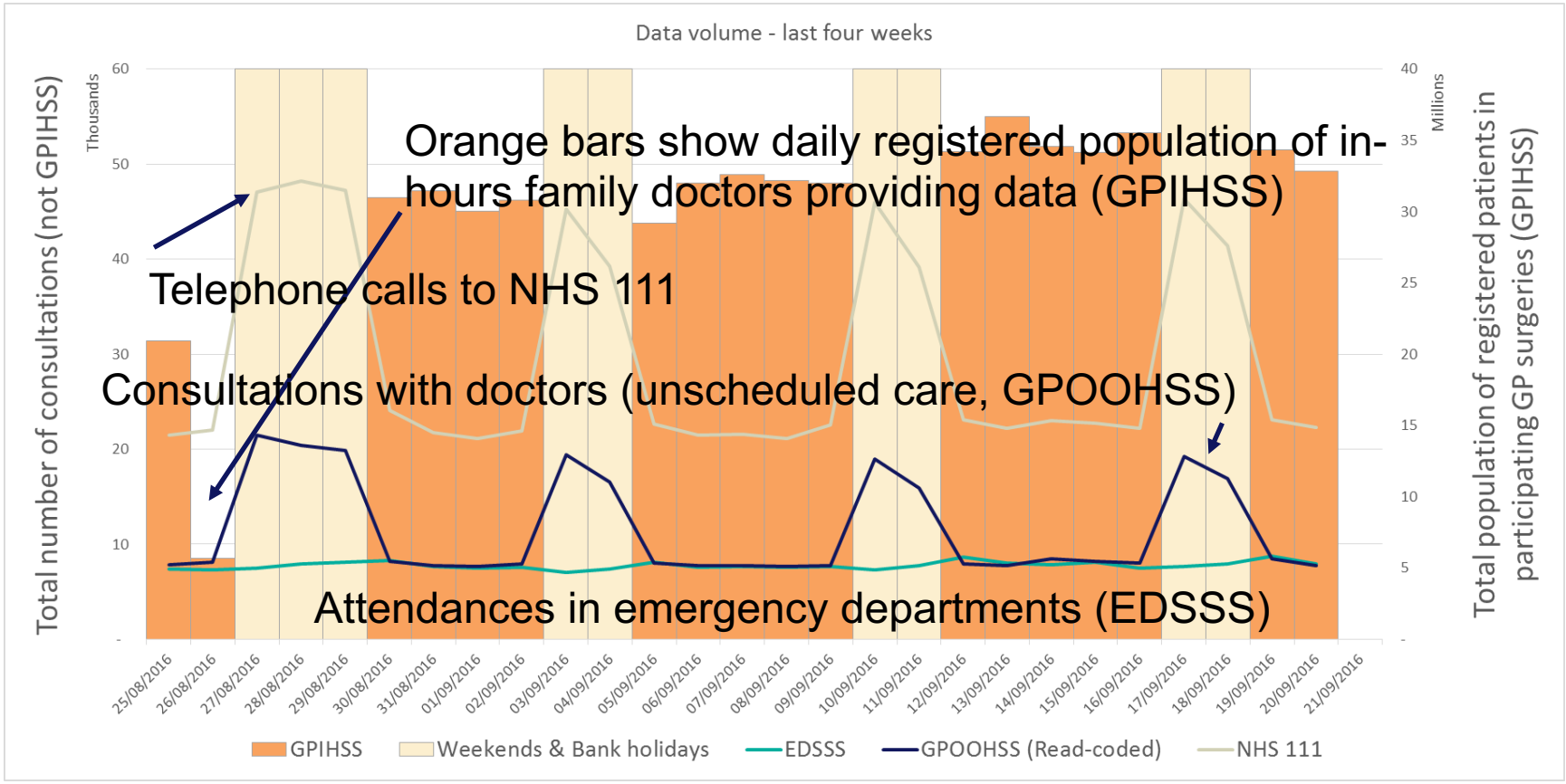
3. Data quality checks



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4. Automated Aberration detection

Today's data compared to model for every signal.

Two alarm thresholds:

Historical alarms – unusually high for the time of year

Spike alarms – significant rise over past two weeks

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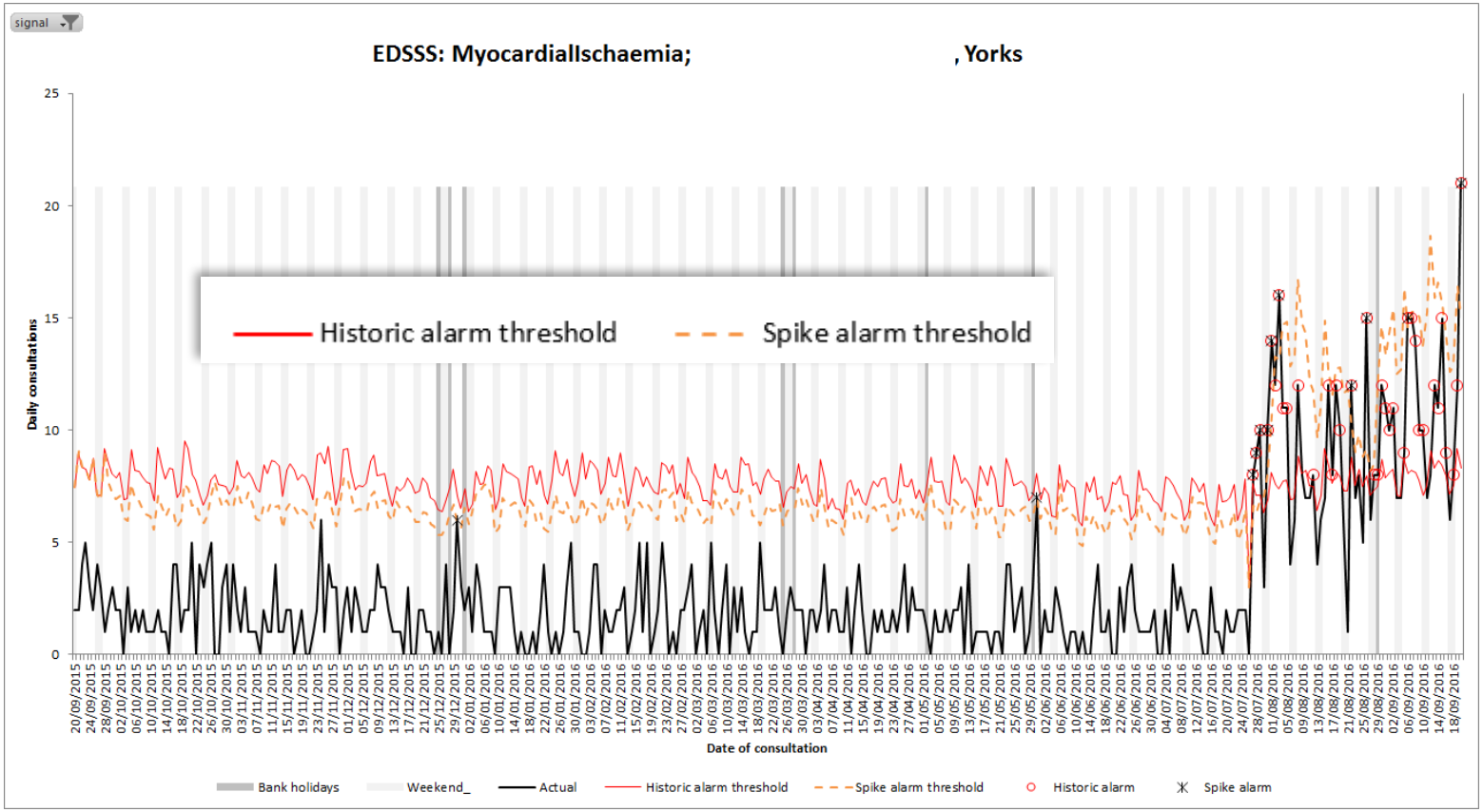
4. Automated Aberration detection



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5. Priority rules

12,000 daily signals, with a 99% alarm threshold

⇨ 120 daily false alarms

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5. Priority rules

a) Daily vs. 4 weekly

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5. Priority rules

a) Daily vs. 4 weekly

b) Winter vs. Summer

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5. Priority rules

a) Daily vs. 4 weekly
b) Winter vs. Summer
c) Repeat vs. First occurrence

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5. Priority rules

a) Daily vs. 4 weekly
b) Winter vs. Summer
c) Repeat vs. First occurrence
d) Local vs. national

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5. Priority rules

a) Daily vs. 4 weekly
b) Winter vs. Summer
c) Repeat vs. First occurrence
d) Local vs. national
e) Specific vs. general

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5. Priority rules

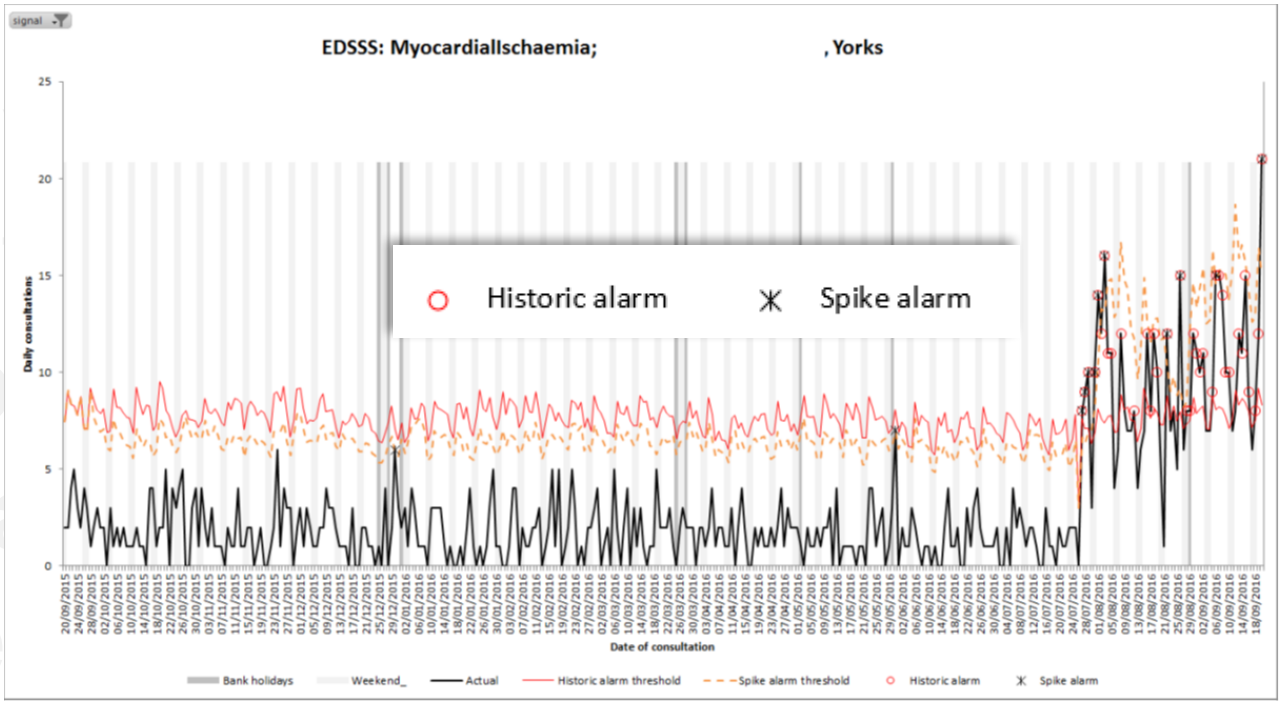
a) Dail

b) Win

c) Rep

d) Loca

e) Spe



f) Manual override

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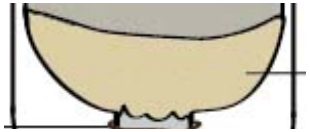

Priority rules

Any questions before going on to risk assessment?

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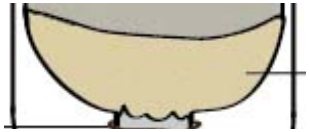
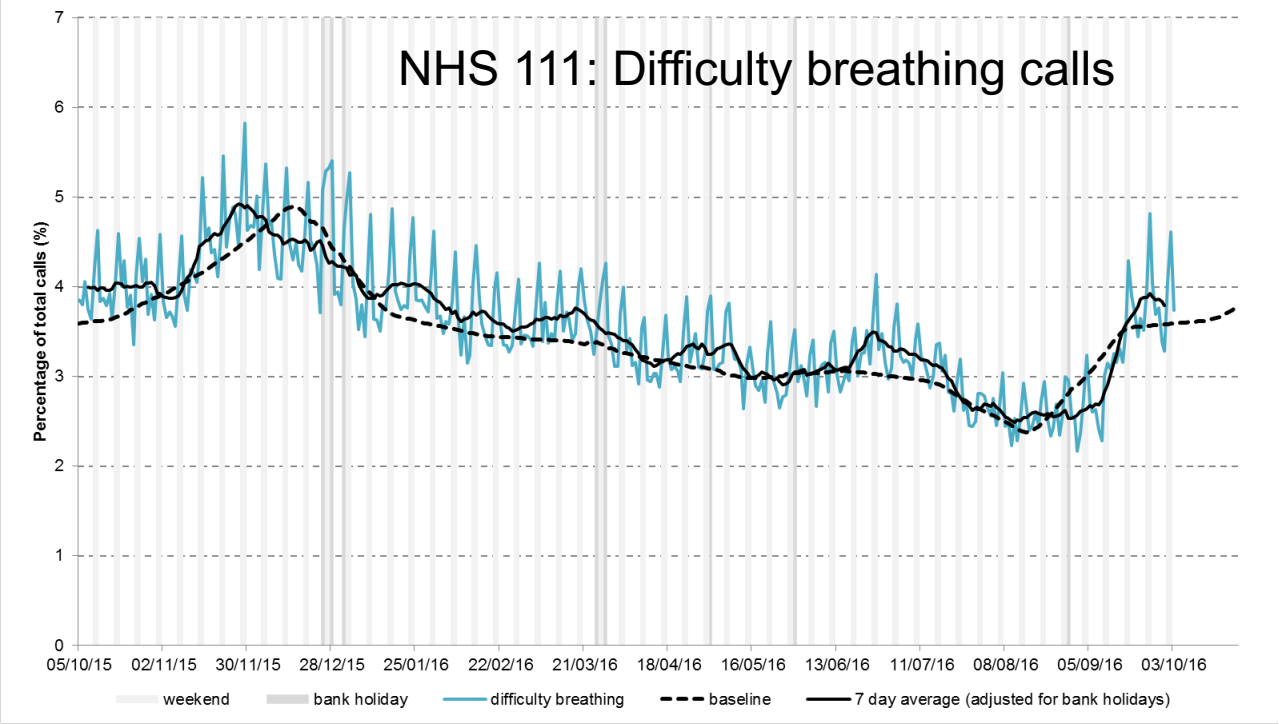


6. Risk Assessment I

Review key national signals



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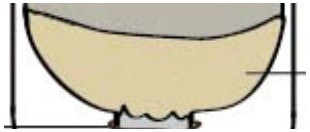

6. Risk Assessment I

Record key message for each system.

GPIHSSS

Today 05/10/2016 Date last assessed 04/10/2016 By PL

Key message All respiratorty indicators increasing within seasonally expected levels.

Data quality 187 QS practices @1pm

Current focus	Comment on current focus	Additional signals to be monitored today
Rugeley fire / Staffs		
Measles in SW	All areas measle rates dropped below baselines	
-		
Current issues with surveillance	None	

No trend Similar
Increasing Above
Decreasing Below

		Combined rate		URTI		ILI		Pharyngitis		LRTI		Pneumonia		Gastroenteritis		Vomiting		Diarrhoea		Severe asthma		Wheeze		Al
Date	Initial	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Trend	Level	Tren
25/08/2016	HH	No trend	Similar	Decreasing	Below	No trend	Similar	Decreasin	Similar	Decreasin	Similar	No trend	Above	No trend	Similar	No trend	Above	No trend	Above	No trend	Similar	Increasing	Above	No tr
26/08/2016	PL	No trend	Similar	Decreasing	Below	No trend	Similar	Decreasin	Below	No trend	Similar	No trend	Similar	Increasing	Below	Increasing	Similar	No trend	Below	No trend	Similar	No trend	Above	No tr
30/08/2016	PL	No trend	Similar	Decreasing	Below	No trend	Below	Decreasin	Below	No trend	Similar	No trend	Above	No trend	Below	No trend	Below	No trend	Below	No trend	Similar	Decreasin	Above	No tr
31/08/2016	PL	No trend	Similar	Decreasing	Similar	No trend	Similar	Decreasin	Similar	No trend	Above	No trend	Above	No trend	Above	No trend	Above	No trend	Above	No trend	Above	Decreasin	Above	No tr
01/09/2016	AE	No trend	Similar	Decreasing	Below	No trend	Similar	Decreasin	Below	No trend	Similar	No trend	Above	No trend	Below	No trend	Below	No trend	Similar	No trend	Similar	Decreasin	Above	No tr
02/09/2016	PL	No trend	Similar	No trend	Below	No trend	Similar	Decreasin	Below	No trend	Similar	Increasing	Above	No trend	Below	No trend	Below	No trend	Similar	Increasing	Similar	Decreasin	Below	No tr
05/09/2016	PL	No trend	Below	Increasing	Below	No trend	Below	No trend	Below	No trend	Similar	Increasing	Above	Increasing	Below	No trend	Similar	No trend	Similar	Increasing	Similar	No trend	Above	No tr
06/09/2016	RAM	No trend	Similar	No trend	Below	No trend	Below	No trend	Below	Increasing	Similar	Increasing	Above	Increasing	Similar	No trend	Below	Increasing	Similar	Increasing	Similar	No trend	Above	No tr
07/09/2016	PL	No trend	Below	Increasing	Below	No trend	Below	No trend	Below	Increasing	Similar	No trend	Above	Increasing	Similar	Increasing	Similar	Increasing	Similar	Increasing	Similar	Increasing	Above	No tr
08/09/2016	HH	No trend	below	No trend	Below	No trend	Below	Decreasin	Below	No trend	Similar	Decreasin	Above	Increasing	Similar	Increasing	Similar	No trend	Above	No trend	Similar	No trend	Above	No tr
09/09/2016	PL	No trend	Below	No trend	Below	No trend	Below	No trend	Below	No trend	Below	Increasing	Above	Increasing	Below	Increasing	Below	No trend	Below	No trend	Below	Increasing	Similar	No tr
12/09/2016	PL	No trend	Below	No trend	Below	No trend	Below	No trend	Below	No trend	Below	No trend	Above	Increasing	Similar	Increasing	Below	No trend	Similar	No trend	Below	No trend	Above	No tr
13/09/2016	PL	Increasing	Similar	Increasing	Below	No trend	Below	No trend	Similar	No trend	Similar	No trend	Above	Increasing	Above	Increasing	Above	No trend	Above	No trend	Similar	Increasing	Above	No tr
15/09/2016	SH	Increasing	Similar	Increasing	Below	No trend	Below	Increasing	Below	No trend	Below	No trend	Similar	Increasing	Similar	Increasing	Below	No trend	Below	No trend	Below	Increasing	Above	No tr
16/09/2016	RAM	Increasing	below	Increasing	Below	Increasing	Below	Increasing	Below	Increasing	Below	No trend	Above	Increasing	Below	Increasing	Below	Increasing	Similar	No trend	Below	Increasing	Above	No tr
19/09/2016	RAM	Increasing	Similar	Increasing	Below	Increasing	Below	Increasing	Below	Increasing	Below	No trend	Above	Increasing	Below	Increasing	Below	No trend	Similar	No trend	Below	Increasing	Above	No tr
20/09/2016	AE	Increasing	similar	Increasing	Below	Increasing	Below	Increasing	Below	Increasing	Below	No trend	Similar	Increasing	Similar	Increasing	Below	No trend	Similar	Increasing	Below	Increasing	Above	No tr
21/09/2016	HH	Increasing	below	Increasing	Below	Increasing	Below	Increasing	Below	Increasing	Below	No trend	Above	No trend	Below	No trend	Below	No trend	Similar	Increasing	Below	Increasing	Above	No tr
22/09/2016	HH	Increasing	below	Increasing	Below	Increasing	Below	Increasing	Below	Increasing	Below	No trend	Similar	No trend	Below	No trend	Below	No trend	Below	Increasing	Below	No trend	Above	No tr

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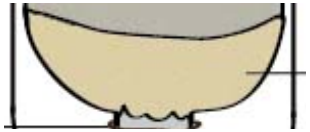
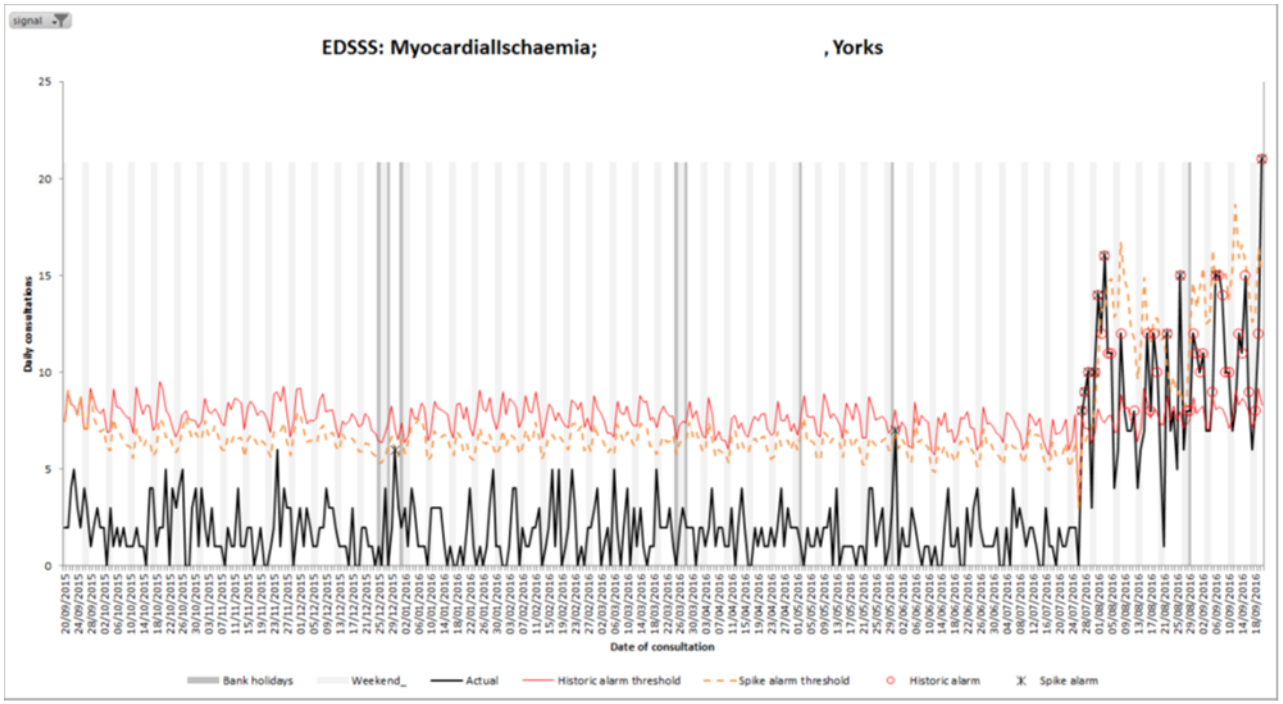


6. Risk Assessment I

Look at prioritised alarms.



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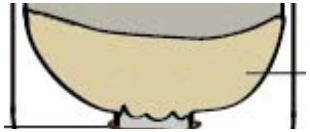

6. Risk Assessment I

Record alarms

Date of unusual activity	*All signals flagged for investigation or with prioritised alarms should be scored.*		
Date	**System**	**Indicator**	**Location**
13/09/2016	GPIHSS	diarrhoea	Middlesbrough
13/09/2016	GPIHSS	gastroenteritis	West Midlands
13/09/2016	GPIHSS	influenza like illness	Knowsley
13/09/2016	GPIHSS	pneumonia	Enfield
13/09/2016	GPIHSS	pneumonia	West Sussex
14/09/2016	GPIHSS	diarrhoea	Buckinghamshire
14/09/2016	GPIHSS	diarrhoea	Gateshead
14/09/2016	GPIHSS	heat stroke	All areas
14/09/2016	GPIHSS	herpes zoster	South West
14/09/2016	GPIHSS	insect bite	All areas
14/09/2016	GPIHSS	pneumonia	Newcastle upon Tyne

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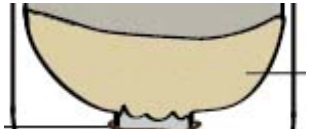

6. Risk Assessment I

Analyst scores each prioritised alarm

i. How far above threshold? (1-3)
ii. Repeat? (1-2)
iii. Against national trend? (1-2)
iv. Multi-system? (1-3)

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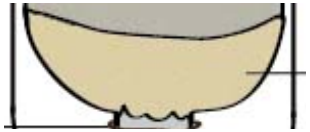

6. Risk Assessment I

Date of unusual activity	*All signals flagged for investigation or with prioritised alarms should be scored.*			First stage risk assessment scoring							
				Was this a priority alarm?	Staff initial and date of first risk assessment		How unusual is the excess?	Is this a repeat?	Does it buck the national trend?	Similar occurred on other systems?	*All scoring 7 or higher must be discussed with consultant*
Date	**System**	**Indicator**	**Location**	**Alarm?**	**Initia**	**Date2**	**Excess score**	**Repea**	**National trend**	**Multi-syster**	**First score**
13/09/2016	GPIHSS	diarrhoea	Middlesbrough	Y	SH	15/09/2016	1	1	2	3	7
13/09/2016	GPIHSS	gastroenteritis	West Midlands	Y	SH	15/09/2016	1	1	2	1	5
13/09/2016	GPIHSS	influenza like illness	Knowsley	Y	SH	15/09/2016	1	1	2	1	5
13/09/2016	GPIHSS	pneumonia	Enfield	Y	SH	15/09/2016	1	1	2	1	5
13/09/2016	GPIHSS	pneumonia	West Sussex	Y	SH	15/09/2016	1	1	2	1	5
14/09/2016	GPIHSS	diarrhoea	Buckinghamshire	Y	SH	15/09/2016	1	1	2	1	5
14/09/2016	GPIHSS	diarrhoea	Gateshead	Y	SH	15/09/2016	1	1	2	1	5
14/09/2016	GPIHSS	heat stroke	All areas	Y	SH	15/09/2016	1	1	2	1	5
14/09/2016	GPIHSS	herpes zoster	South West	Y	SH	15/09/2016	1	1	2	1	5
14/09/2016	GPIHSS	insect bite	All areas	Y	SH	15/09/2016	1	1	2	3	7
14/09/2016	GPIHSS	pneumonia	Newcastle upon Tyne	Y	SH	15/09/2016	1	1	2	1	5
15/09/2016	111	diarrhoea	Sandwell	Y	RAM	16/09/2016	1	1	2	1	5
15/09/2016	111	difficulty breathing	All areas	Y	RAM	16/09/2016	1	2	2	1	6
15/09/2016	111	fever	All areas	Y	RAM	16/09/2016	1	1	2	1	5
15/09/2016	111	fever	Liverpool	Y	RAM	16/09/2016	1	1	2	1	5
15/09/2016	111	fever	London	Y	RAM	16/09/2016	1	1	2	1	5
15/09/2016	111	Insect Bites	All areas	Y	RAM	16/09/2016	1	2	2	3	8

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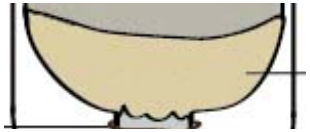

7. Risk Assessment II

On-call epidemiologist reviews alarms

v. Is it unusual for season? (1-2)
vi. Unusual spatial clusters? (1-2)
vii. Change in age distribution? (1-2)
viii. Increase in severity? (1-2)

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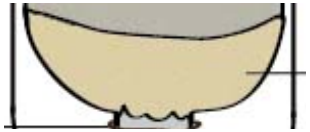

7. Risk Assessment II

Signal investigation record		Consultant second stage risk assessment									
This column automatically filled in.	Date of unusual activity	Consultant and date of second risk assessment		Is it unusual for the time of year?	Is there unusual spatial clustering?	Is there unusual age clustering?	Is there an increase in serverity?	*Score above 12 normally Alert.* Total score	Record any further actions or investigations required.		Continue to monitor, no action or Alert
Signal	Date	Initia	Date	Seaso	Geograp	Age	Severi		Consultant summary		Decisi
GPOOHSS: Impact of heat; Portsmouth	18/09/2016										
GPOOHSS: Insect bite; All areas	18/09/2016	GS	20/09/2016	2	1	1	1	13	alert : NSAC message		alert
GPOOHSS: Insect bite; Portsmouth	18/09/2016										
GPOOHSS: Rash; Warwickshire	18/09/2016										
GPOOHSS: Trauma; All areas	18/09/2016										
GPOOHSS: Trauma; Hampshire	18/09/2016										
GPOOHSS: Trauma; Portsmouth	18/09/2016										
GPOOHSS: Trauma; South East	18/09/2016										
GPOOHSS: Trauma; Southampton	18/09/2016										
GPOOHSS: Vomiting; North West	18/09/2016										
GPIHSS: diarrhoea; Essex	16/09/2016										
GPIHSS: diarrhoea; North Yorkshire	16/09/2016										

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8. Outputs

Respiratory

System	Indicator	09/09/16	12/09/16	13/09/16	14/09/16	15/09/16	16/09/16	19/09/16	20/09/16	21/09/16	22/09/16
ED	ARI	→		↗	↗	↗	↗	↗	↗	↗	↗
GPOOH	ARI	→	→	→	↗	↗	↗	↗	↗	↗	↗
GPIH	URTI	→	→	↗		↗	↗	↗	↗	↗	↗
NHS 111	Cold/flu	→	→	→	↗	↗	↗	↗	↗	↗	↗
NHS 111	Fever (5-14 year olds)	↗	↗	→	→	→	→	→	→	→	→
EDSSS	Influenza-like illness	→		→	→	→	→	→	→	→	→
GPIH	Influenza-like illness	→	→	→		→	↗	↗	↗	↗	↗
GPOOH	Influenza-like illness	→	→	→	→	→	→	↗	↗	↗	↗
GPIH	LRTI	→	→	→		→	↗	↗	↗	↗	↗
NHS 111	Cough	→	→	→	→	→	↗	↗	↗	↗	↗
ED	Bronchitis	→		→	→	→	→	↗	↗	↗	↗
GPOOH	Bronchitis	→	→	↗	↗	↗	↗	↗	↗	↗	↗
ED	Pneumonia	→		↗	↗	→	→	→	→	→	↗
GPIH	Pneumonia	↗	→	→		→	→	→	→	→	→
GPIH	Pharyngitis / SF	→	→	→		↗	↗	↗	↗	↗	↗
GPOOH	Pharyngitis / SF	→	→	→	→	→	→	↗	→	→	→
NHS 111	Difficulty breathing	→	→	→	↗	↗	↗	↗	↗	↗	↗
ED	Asthma/Wheeze/DB	→		→	↗	↗	↗	↗	↗	↗	↗
GPOOH	DB/Wheeze/Asthma	→	→	→	↗	↗	↗	↗	↗	↗	↗
GPIH	Severe asthma	→	→	→		→	→	→	↗	↗	↗

Gastrointestinal

System	Indicator	09/09/16	12/09/16	13/09/16	14/09/16	15/09/16	16/09/16	19/09/16	20/09/16	21/09/16	22/09/16
ED	Gastroenteritis	↘		→	↘	→	→	→	→	→	↘
GPIH	Gastroenteritis	↗	↗	↗		↗	↗	↗	↗	→	→
GPOOH	Gastroenteritis	→	→	→	↘	→	→	→	↘	↘	↘
NHS 111	Diarrhoea	→	↘	↘	↘	↘	↘	↘	↘	↘	↘
GPIH	Diarrhoea	→	→	→		→	↗	→	→	→	→
GPOOH	Diarrhoea	→	↘	↘	↘	↘	↘	→	→	→	↘
NHS 111	Vomiting	→	↗	→	↗	↗	↗	→	→	↗	↗
GPIH	Vomiting	↗	↗	↗		↗	↗	↗	↗	→	→
GPOOH	Vomiting	→	→	→	→	→	→	→	→	→	→

Indicator Key		
	↗ Increasing	Higher than previous years
	→ No trend	Similar to previous years
	↘ Decreasing	Lower than previous years

RAMMIE prioritised alarm

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8. Outputs

Air Pollution 12th & 13th March 2016

UK-AIR data: 12/03/2016 (View Latest)
Summary from 148 monitoring sites

UK-AIR data: 13/03/2016 (View Latest)
Summary from 148 monitoring sites

Index Bands

1	2	3	4	5	6	7	8	9	10
Low			Moderate			High			Very High

No relevant increase seen in Asthma/wheeze/difficulty breathing indicators for EDSSS or GPOOHSS.

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PHE Syndromic Surveillance Summary

Produced by the PHE Real-time Syndromic Surveillance team

04 October 2016 — **Year: 2016 Week: 39**

Syndromic surveillance national summary:

Reporting week: 26 September to 2 October 2016

There were continued increases in a range of respiratory conditions during week 39 (including acute respiratory infection and asthma/wheeze/difficulty breathing) in line with seasonally expected activity.

Click to subscribe to the weekly syndromic surveillance email

Remote Health Advice:

During week 39 there were further increases in cold/flu, cough and sore throat calls (figures 2, 4, 6). There was however a decrease in the number of NHS 111 difficulty breathing calls, which was particularly noted in the 1-4 and 5-14 years age groups (figures 5 & 5a).

Click to access the Remote Health Advice bulletin

GP In Hours:

During week 39 GP consultations for respiratory conditions including upper and lower respiratory tract infections continued to increase, but remain within seasonally expected levels (figures 1 and 5).

There were further increases in consultations for asthma, these increases were particularly noted in children aged 5-14 years (figures 10 and 10a).

Click to access the GP In Hours bulletin

Emergency Department:

During week 39 there were no further increases in respiratory attendances, including acute respiratory infections and asthma/ wheeze/ difficulty breathing (figures 7, 8, 10). There was however a further increase in attendances for bronchitis/ bronchiolitis attendances in young children, as would be expected at this time of year (figure 10, 11).

Click to access the EDSSS bulletin

GP Out of Hours:

During week 39 there were further increases in GP out of hours consultations for a number of respiratory conditions including acute respiratory infection and difficulty breathing/wheeze/asthma (figures 2 and 5).

Click to access the GPOOHSS bulletin

RCGP Weekly Returns Service:

Click here to access reports from the RCGP website [external link]

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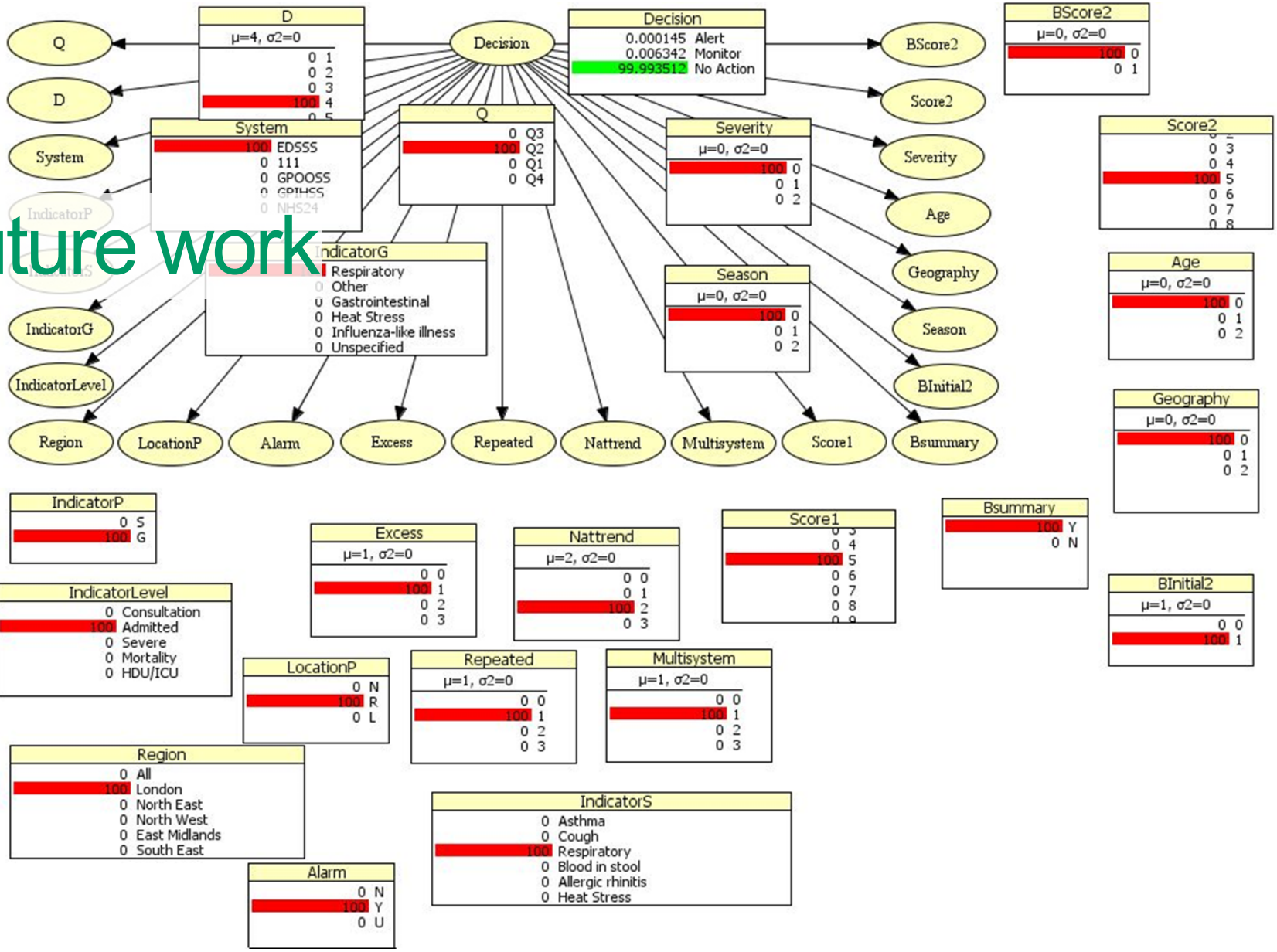
Future work

- Validation of local signals vs cryptosporidium outbreaks
- Development of age specific signals
- Analysis of decision making process via Bayesian Networks

Future work


Q
D
System
IndicatorP
IndicatorG
IndicatorLevel
Region
LocationP
Alarm
Excess
Repeated
Nattrend
Multisystem
Score1
Bsummary
BInitial2
Geography
Season
Age
Severity
Score2
BScore2
Decision
0.000145 Alert
0.006342 Monitor
99.993512 No Action
μ=4, σ2=0
μ=0, σ2=0
μ=1, σ2=0
μ=2, σ2=0
0 Asthma
0 Cough
100 Respiratory
0 Blood in stool
0 Allergic rhinitis
0 Heat Stress
0 Other
0 Gastrointestinal
0 Heat Stress
0 Influenza-like illness
0 Unspecified
0 Consultation
100 Admitted
0 Severe
0 Mortality
0 HDU/ICU
0 All
100 London
0 North East
0 North West
0 East Midlands
0 South East

Public Health England

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Public Health England

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The End