

A low-angle photograph of a stone tower from Lincoln Castle. The tower is made of light-colored stone blocks and has several windows. A Union Jack flag flies from a tall pole on top of the tower. The sky is a clear, bright blue.

# Annual Report of the Director of Public Health on the health of the people of Lincolnshire 2017



# Forward

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**It is my duty, and pleasure, as Interim Director of Public Health (DPH) for Lincolnshire during 2017 and early 2018 to present an annual report on the state of the health of the people of Lincolnshire.**

This report is as eclectic in its content as is the practice of public health as a local authority Public Health Team. I have chosen two main areas to reflect on this year, for entirely different reasons.

I reflect on the environmental hazards which present risk to the health of our population as it is some time since a Lincolnshire DPH reflected on this key area of responsibility and because the magnitude of some of the risks prevalent internationally at the moment are truly momentous. The pandemic potential of new strains of common organisms such as influenza, some measure of effect we have seen in the flu season just coming to a close is a clear and present risk to health. Alongside this, our reliance on, and relatively poor stewardship of, established antimicrobial medicines is presenting significant risk to individual patients through infection with resistant organisms. This risk has more than a theoretical potential to escalate into a global threat from the emergence of organisms for which our antimicrobial arsenal has no effective response.

The ageing nature of the population of the United Kingdom is well understood and the age profile of people in Lincolnshire is in many ways a somewhat more concentrated example of this overall national trend.

This demographic trend is often described in health and care terms as a significant threat or challenge to the sustainability of local systems of care. The models of strategic planning that bind to this view have been referred to in research literature as 'Apocalyptic Demography'. They tend to present ageing and worsened health and independence and subsequent increases in need or demand for care as an unavoidable scenario for which society and services can only prepare.

An exploration of the current associations between ageing, maintenance of independence and sustaining of good health quickly give hope of an alternative scenario in older age for much of the population. If there are significant differences in both lived experience and expectation in ageing between people living in the same communities already, this suggests it should be possible to level up expectations for everyone and create better separation between ageing and infirmity for more people.

The alternative health and care scenarios that could be realised by focusing on improving the forecast health and wellbeing of all local people to that somewhere near the expectations of our best communities are there to be achieved.

In an environment where the entire system of health and care is engaged in managing today's demands, it is an essential role of a local Director of Public Health to remind the system leaders of the opportunities offered in prevention. My purpose with this Annual Report is to do just that, to put the argument for prevention in the context of potentially apocalyptic local demography.

I trust you will be stimulated by the presentation of some of the thinking nationally and internationally on this most complex of issues.



**Tony McGinty**

Interim Director of Public Health  
for Lincolnshire

October 2016 to January 2018

# List of Contributors

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## Ageing and Health

- **Andy Fox,**  
Specialist Registrar in Public Health
- **Michael Toze,**  
University of Lincoln

## Health Protection

- **Saran Shantikumar,**  
Public Health Registrar,  
Public Health England East Midlands
- **Graeme Hemsall,**  
Emergency Planning Officer,  
Lincolnshire County Council
- **Dr Jharna Kumbang,**  
Consultant in Communicable  
Disease Control,  
Public Health England East Midlands
- **Gail Beckett,**  
Senior Health Protection Nurse,  
Public Health England East Midlands
- **Haymond Lam,**  
Environmental Public Health Scientist,  
Centre for Radiation, Chemical  
and Environmental Hazards,  
Public Health England
- **Stuart Aldridge,**  
Environmental Public Health Scientist,  
Centre for Radiation, Chemical  
and Environmental Hazards,  
Public Health England

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# Ageing and Health: The Potential of Prevention

## The relationship between ageing and health

The health of the ageing population of Lincolnshire is not significantly different to that of the health of similar populations in the East Midlands and England as a whole. Evidence is clear that some progression towards poor health and greater limitations on physical fitness are to be expected as we age.

The prevalence of common conditions such as osteoarthritis and hypertension increase as we age, and we see significant increases in the rates at which people begin to suffer functional mental illness and cognitive impairments such as dementia. Declines in physical strength, fitness and balance may lead to increased risk of falling whilst osteoporosis may incline more people who do fall to suffer a joint or bone fracture.

Declining flexibility in our cardiovascular systems combined with more tendency towards hypertension result in an increasing incidence of stroke in older age.

Ageing generally decreases our resilience, recovery potential and recovery rates following an adverse health event or injury.

This picture of increased risk of a range of incidents and conditions as we advance into older age is problematic in itself, as people will cope differently with the onset of these conditions.

There is evidence, however, that a multiplier effect in likely loss of independence and a need for support to daily life activities occurs when an individual experiences more than one illness, or loss of faculty. Figure 1 provides a simple analysis of the relationship between the number of long term conditions experienced by individuals and the average health and social care cost of support.

In the UK currently, over 50% of people older than 65 have at least two chronic conditions (Barnett, Mercer, et al 2012) (Salive, 2013). This is known as multi-morbidity. Importantly, the health conditions that can contribute to multi-morbidity are varied, are not restricted to individual 'diseases', and include:

- *Symptom complexes such as chronic pain or frailty*

- *Sensory impairment such as hearing or sight loss*
- *Ongoing conditions such as a learning disability*
- *Physical conditions such as diabetes*
- *Defined mental health conditions such as schizophrenia*
- *Alcohol and substance misuse (National Institute for Health and Care Excellence, 2016)*

Figure 1 demonstrates that each condition present multiplies the cost of care for each individual. These costs are made up of a range of interventions across health and care. Having two or more such conditions increases the likelihood of hospital admissions, risk of mortality, likelihood of relying on multiple prescriptions, and risk of dependency (Kingston, Robinson, et al., 2018) (Marengoni, Angleman, et al., 2011).

It is evident that the numbers of people who suffer from these conditions or who have health problems within a health and social care community, are higher where there are relatively more older people. The acceptance of a reasonable degree of correlation between the age of an individual and risk to their health is important. It is evident that older populations will have more health and support needs and will therefore consume health and care at a greater rate than younger populations.

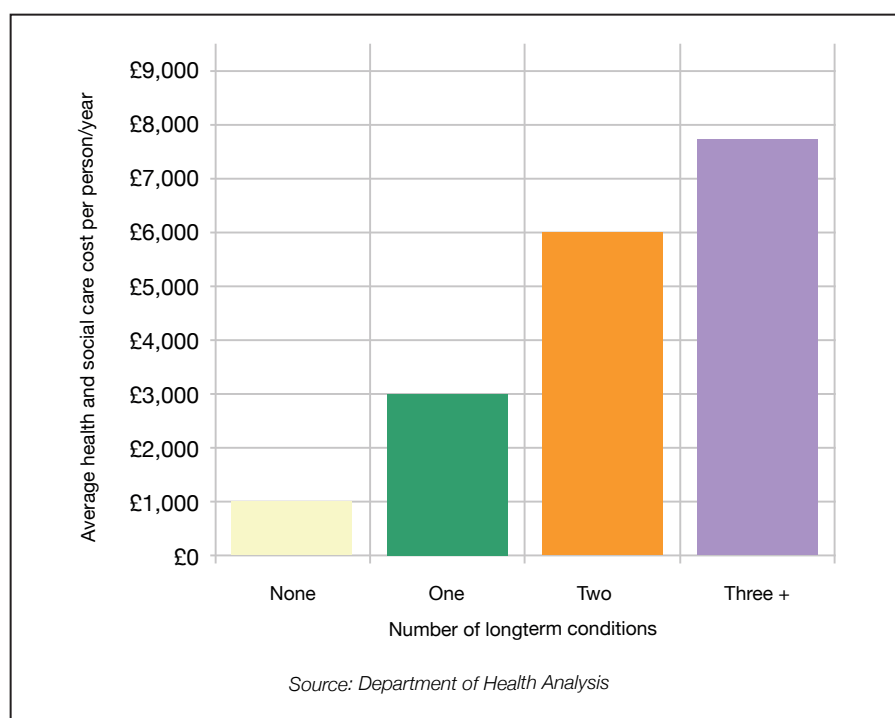
This is important for the population of Lincolnshire as we have a higher proportion of people over the age of 65 than the average across England and this proportion is expected to increase more rapidly than in other parts of the Country.

In 2017, the population of Lincolnshire counted approximately 750,000 people. Of these, some 130,000 were over the age of 65, and this proportion is likely to grow. The expectation is thus for increased demand on the health and care in Lincolnshire in the future. It would be easy to translate this simply into planning to meet more and more complex health and care needs as a system response.

However, a 'demand planning' approach alone would have to presume that the increase in age profile is necessarily matched by growth in need for health and care interventions.

# Ageing and Health: The Potential of Prevention

Figure 1: Summation of the Relationship Between Number of Long Term Conditions and Cost of Care



## Ageing, disease and disability are not inextricably linked

People do not wish to spend their older years with poor health or loss of independence, and given a choice between being treated for a condition and never having had that condition, most people could be expected to choose the latter. Having excellent health and care services to prevent deterioration, treat and care for older people in poor health is vital to support them to maximise the value of their remaining years of life. The biggest overall gain is achieved when a pathway of prevention is available that seeks to prevent disease entirely, slow or prevent its progression and support people to live well with illness and disability.

Setting aside discussion of the health of future older people, it is clear that experiencing poor health in old age is not inevitable from the experiences of the older people already living in Lincolnshire. Whilst it is true that the majority of people over the age of 65 in the County are living with a chronic condition, it is also true that a significant percentage are living without such conditions and the limitations they may impose.

In Lincolnshire, there are clear differences in the degree to which different groups develop illness as they age. As we will see, if some groups are more likely to get ill

than others in old age, we should not consider illness inevitable for all. These differences in the experiences of groups within our existing older populations should instead lead us to consider the characteristics of the people avoiding poor health and asking how these characteristics may be made available to other older people.

The factors, decisions and underlying conditions in communities which may prevent illness in old age for those who are approaching this time of life, or even those who are younger now, are evidently complex. However, there is plentiful evidence of effectiveness for interventions that will support better health as people go through life, with benefit to their health as they age.

This means potentially thousands of people in Lincolnshire who may be on pathways towards developing chronic conditions in later life could be helped to change their trajectory.

# Ageing and Health: The Potential of Prevention

## Longer life, better health, or both?

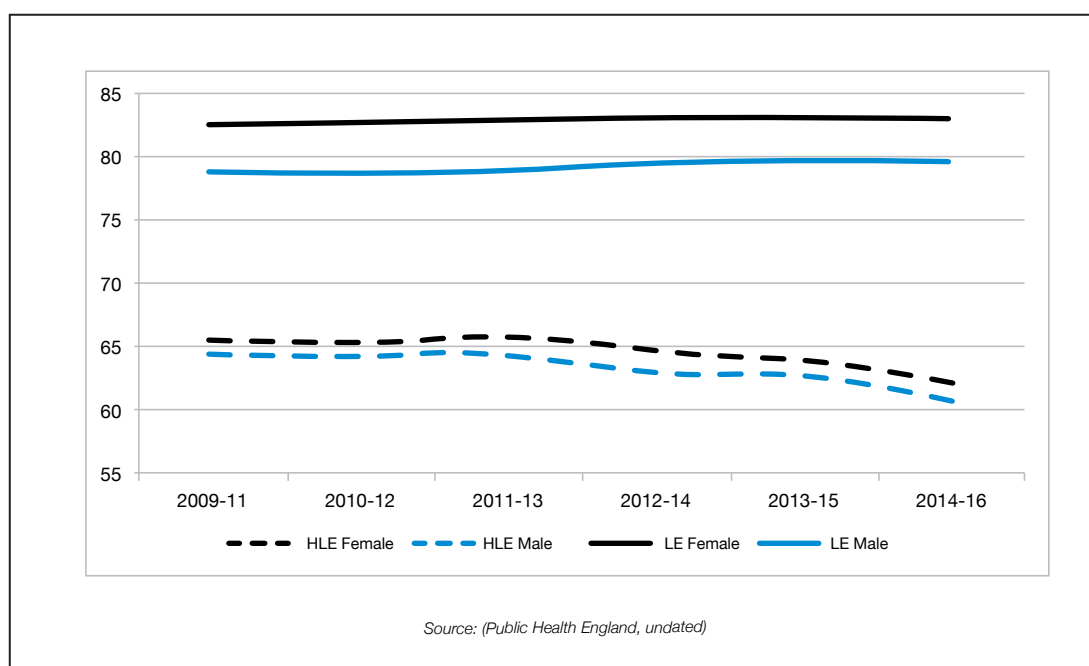
Although the last 40 years has seen continuous growth in life expectancy in Lincolnshire, not all of these extra years are always spent in good health. Figure 2 shows us the trend over the last 5 years of available data for healthy life expectancy and life expectancy in Lincolnshire. We can see that in this time period, life expectancy has continued to slowly increase whilst healthy life expectancy has actually decreased slightly.

In Lincolnshire in recent years then, the gap between healthy life expectancy and life expectancy has widened

i.e. on average, people are spending more years in ill health as their life expectancy increases.

Whilst data for Lincolnshire is relatively small in number to draw major policy conclusions from, the trend described is matched when the much larger data sets at East Midlands and England level are subject to the same analysis. There is even some evidence starting to emerge that this loss of healthy life expectancy is soon to be followed by the first reduction in overall life expectancy.

Figure 2: Health Life Expectancy (HLE) and Life Expectancy (LE) in Lincolnshire, 2009-11 to 2014-16



# Ageing and Health: The Potential of Prevention

## What does ‘poor health’ or ‘multi-morbidity’ look like?

It would help at this point to understand exactly which conditions contribute to poor health in old age, or ‘multi-morbidity’ as it is also known. Table 1 lists many of the conditions which affect people in old age, along with the percentage of people over the age of 65 in the UK who we would expect to be living with this condition.

Although these conditions are prevalent in the current population of over 65s in both the UK and Lincolnshire, they are unevenly distributed, with some populations

aged over 65 years experiencing far higher rates of these conditions than others. It is well documented in the evidence base, that it is not inevitable that people will develop these conditions as their risks increase due to ageing. Across these conditions, and their increasing risk over time, the highest impact causes, and cause of the causes, could be described as in Figure 3.

Table 1: Prevalence of key conditions in UK over 65 population

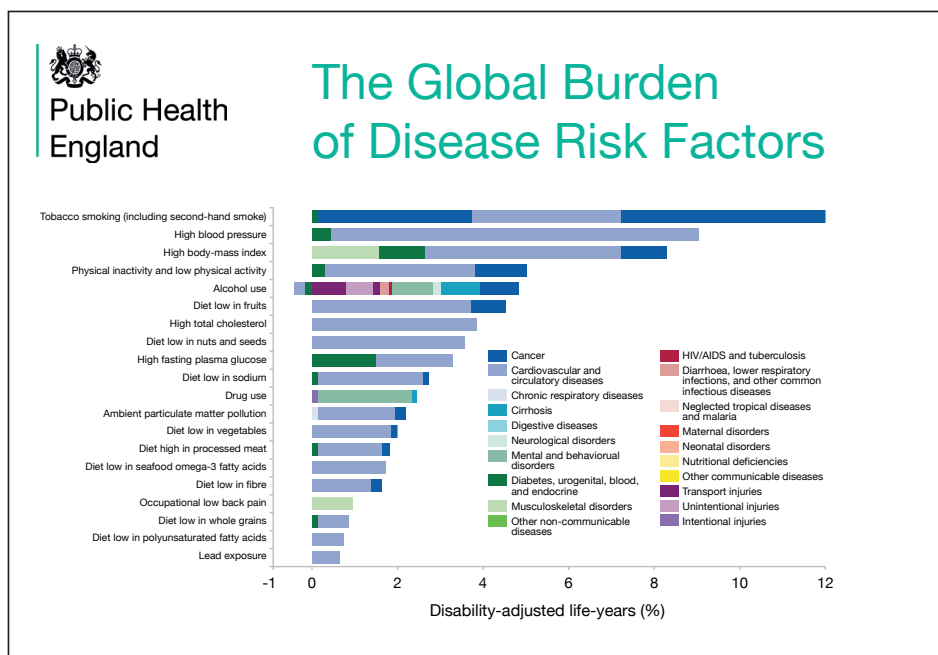
Condition	%
Hypertension	49.0%
Arthritis	48.6%
Coronary Heart Disease	18.3%
Respiratory	18.0%
Diabetes	14.7%
Cancer	12.6%
Hearing Impairment	12.4%
Stroke	7.5%
Dementia	6.8%
Visual Impairment	6.2%
Cognitive Impairment (Not Dementia)	2.7%
Depression	2.3%

(Source: Kingston, Robinson, et al., 2018)



# Ageing and Health: The Potential of Prevention

Figure 3: The Global Burden of Disease Risk Factors



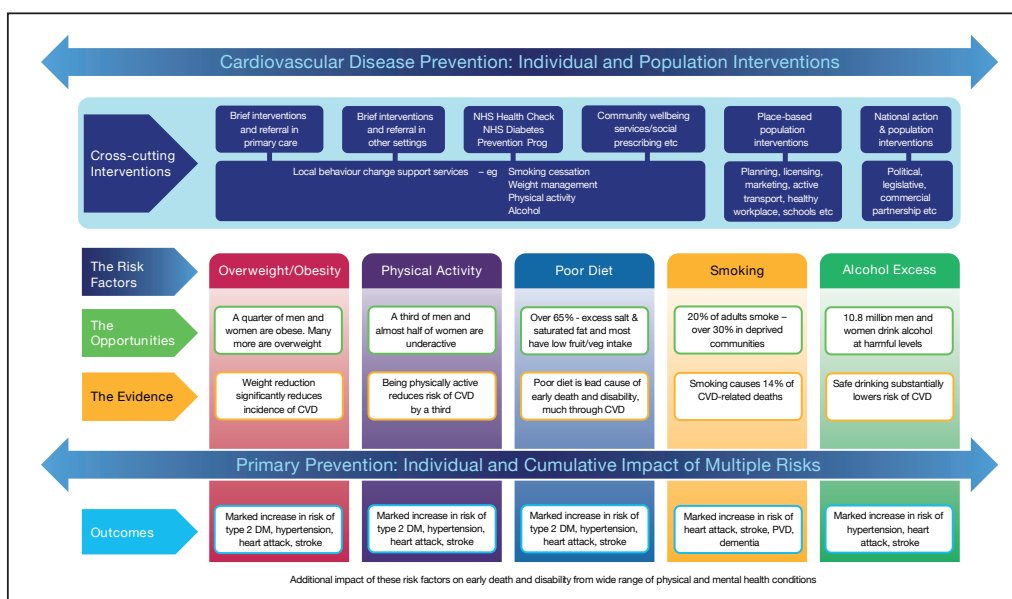
Source: Public Health England, 2015 a

There is also plentiful evidence that even once these conditions are present, the impact and outcomes for people can be managed through effective self and professional management of the conditions. The most effective interventions at this stage of chronic condition often include addressing the factors in Figure 3.

This generalised model can be supplemented for specific disease types, like cardiovascular disease, as summarised in Figure 4.

The magnitude of the overall effect on people's health experiences of the effective implementation of these interventions as they age is described later in the report.

Figure 4: Cardiovascular disease prevention – individual and population interventions



Source: Public Health England: 2016 b

# Ageing and Health: The Potential of Prevention

## Protective factors, risk factors and triggers

To give best effect to preventative approaches to ageing, it is important to ensure that evidence based general preventative interventions at population scale (Figure 2) and the best possible disease specific interventions (Figure 3) are in place.

The evidence base on healthy ageing is clear, however, achieving these goals alone for a population like Lincolnshire's will not maximise the outcomes for ageing adults at risk of poorer health experiences.

There is significant evidence that some declines into poor health; loss of independence or control of existing conditions can be exacerbated or triggered by an event such as having to change accommodation; a bereavement or an injury from something like a fall.

Discussions of later life housing can have a tendency to focus on specialist accommodation such as care homes, sheltered and extra care housing. However, 93% of people aged over 65 years live in mainstream housing and many would seek to remain there for as long as is practical (Keenan, 2010; Pannell et al., 2012). The translation of this desire for older people (and perhaps for housing, health and care strategists) requires a broader conceptual view which might be described as 'ageing in place' (Wiles et al., 2012; Van Disk et al., 2014) and needs to include factors such as: perception of the area; quality of local amenities and transport links. It is clear, however, that an effective approach to housing for older people is an important

factor in protecting people from decline into illness and disability as they age.

In Lincolnshire, only 48% of adult social care users say that they get as much social contact as they would like (Public Health England), and being lonely and cut off from family and friends is known to increase the risk of frailty by 85% (Gale, Westbury, et al., 2017).

It is important in this context to accept the subjective experiences of people being alone and experiencing loneliness. Victor, Scrambling, et al. (2005) found that in a nationally representative sample of people aged over 65, whilst 61% described themselves as never lonely and 2% as always lonely, there was no correlation between these feelings and contact with family or friends. The issue is rather more to do with psychological and social functioning in the place where people live. The evidence base suggests a need to incorporate explicit assessments with individuals to properly understand this risk factor for poor health and demand on services is the only way to ensure the complex subjective experiences of people are catered for (Victor and Bowling, 2012).

Having a fall can be a minor inconvenience but for some it can have serious consequences. In Lincolnshire during 2015/16, there were over 2,800 hospital admissions for people aged over 65 due to a fall. Falls can cause injury but they are also linked to social isolation. (Public Health England, Undated)

## Why is poor health not inevitable?

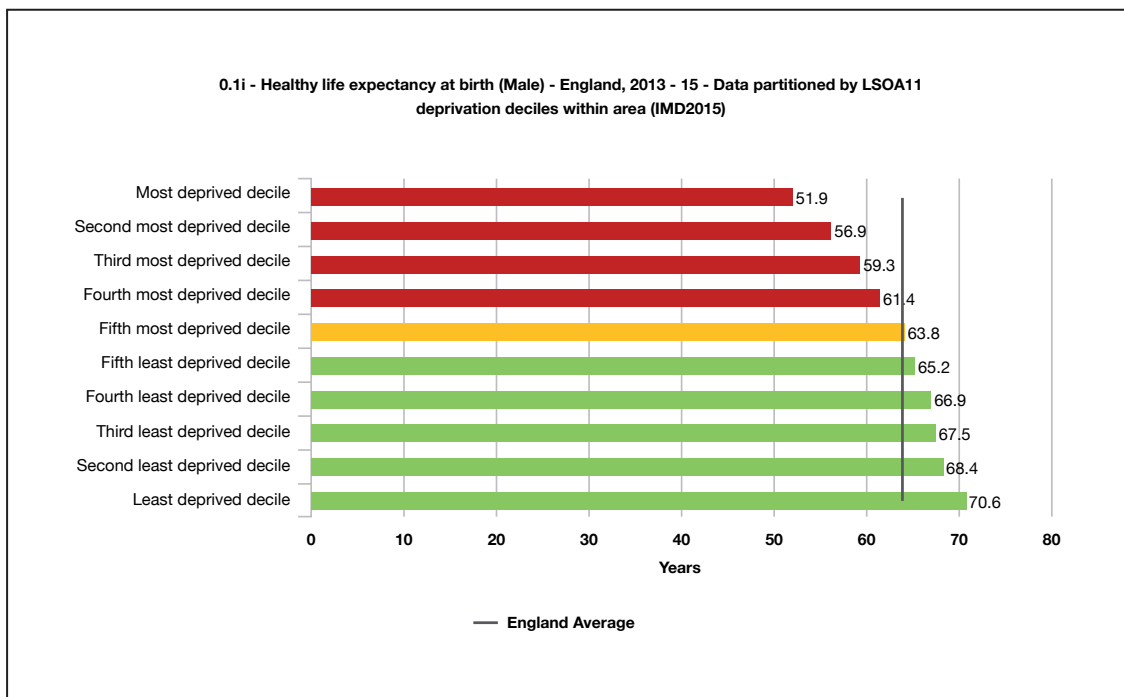
There are groups of people in Lincolnshire who have far better health than others. The evidence shows that people from the higher socio-economic groups, i.e. those people who are relatively better off than others, have much better health in old age than their peers with less resources.

To observe this from known intelligence sources, Figure 5 shows that in England, the tenth of the

population with the highest socio-economic status can expect to live almost twenty years longer in good health than the tenth of the population who are the most deprived. This demonstrates that an unhealthy old age, with multi-morbidity, is not inevitable but can be linked to influencable factors such as our resources, our lifestyle, our opportunities, and our environment.

# Ageing and Health: The Potential of Prevention

Figure 5: Healthy life expectancy at birth (for men) by deprivation decile

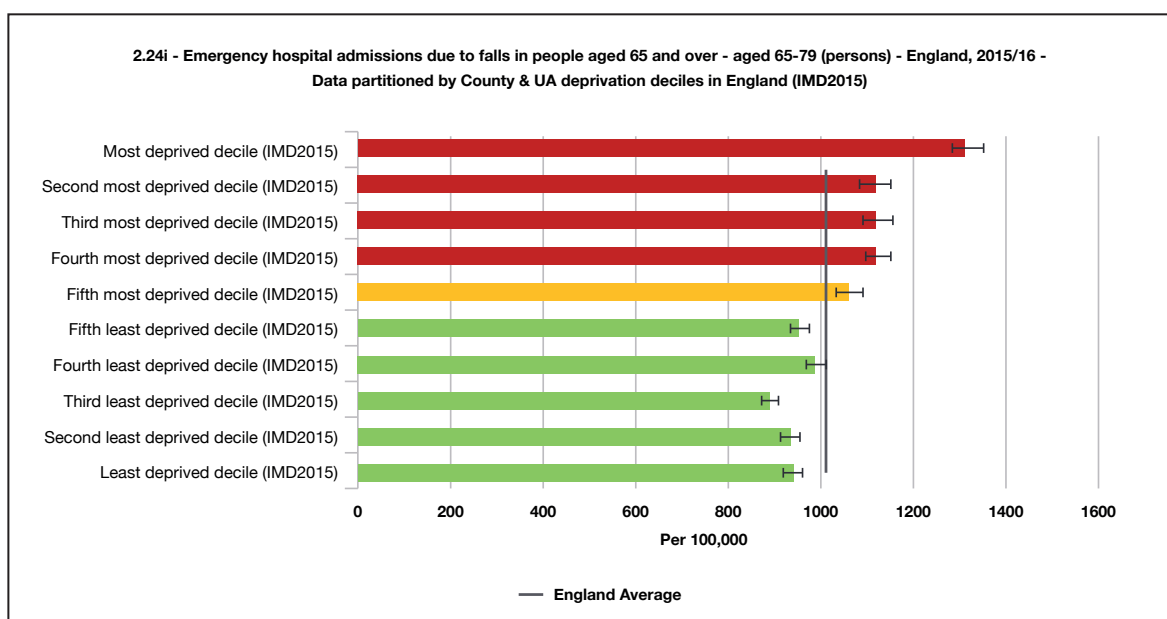


Source: (Public Health England, undated)

As an example of this for one of the trigger factors described above, Figure 6 shows the rate of hospital admissions due to falls in England by 'deprivation decile'. This shows that the tenth of the population of Lincolnshire who have the highest socio-economic

status are approximately a third less likely to have a fall that results in a hospital admission than the most deprived tenth of the population. Importantly, this difference is statistically significant, which means that it is very unlikely to have happened by chance.

Figure 6: Hospital admissions due to falls by deprivation decile



Source: (Public Health England, undated)

# Ageing and Health: The Potential of Prevention

## The potential of prevention

If poor health in older age is not inevitable, but is influenced by many things, including lifestyle and environment, it follows that if we make changes to these things, we could prevent some of this expected disease.

Much academic work has been completed to study just how amenable to preventative interventions some of these conditions are, and we can summarise samples of the available evidence here.

## Physical activity for better older health

Behavioural and lifestyle interventions, such as meeting the recommended level of physical activity for adults, can have a major preventative effect on a number of conditions that contribute towards frailty and ill-health in older age. Consequently they have potential to reduce

the degree of ill-health faced by the population of Lincolnshire, as well as easing the pressure on the health and social care system and the local economy. Table 2 below lists potential reduction in lifetime risk if individuals maintain the recommended level of physical activity.

Table 2: UK lifetime risk for key conditions and the effect of maintaining physical activity

Condition	UK lifetime Risk	Reduction due to physical activity	Lifetime risk for physically active
Hypertension	70%	50%	35.0%
Osteoporosis	50%	40%	30.0%
Stroke Incidence	17%	30%	11.9%
Arthritis	14%	50%	7.0%
Dementia	13%	30%	9.1%
T2 Diabetes	10%	50%	5.0%

(Source, Public Health England, undated) (ONS, 2017)

If we apply these lifetime risk figures to the current population of Lincolnshire, we get a glimpse of the huge potential in preventative interventions. Lincolnshire’s population is estimated to be approximately 750,000 people – 70% of whom would normally be expected to develop hypertension (high blood pressure) at some point in their life. If everyone remained physically active, we could expect this percentage to be halved.

To put that into context, we would expect hundreds of thousands of people to be spared having to deal with high blood pressure, and a corresponding reduction in ill-health in old age. Importantly, this is just from the benefits of staying physically active and other important preventative interventions like maintaining a healthy diet, and staying socially connected rather than isolated may add to the effect.



# Ageing and Health: The Potential of Prevention

## Strength and balance for older age

It is known that strength and balance training (a physical activity intervention for older people) can reduce the risk of falling by up to 29% (Public Health England, 2017a). Consequently, we could expect to prevent one fall for every 4 people who engaged in such training. There is a considerable economic benefit to be had for the health system from preventing falls, as each fall that results in a hospital admission has been estimated to cost the

NHS £5,000 (The Chartered Society of Physiotherapy, undated). There may well be further cost savings to the health and social care system if injury is prevented, as well as wider costs to the economy. The total cost of fragility fractures to the UK economy has been estimated at £4.4bn, which includes £1.1bn of social care costs. Hip fractures are estimated to make up nearly half of this total cost (Public Health England, 2017a).

## Stroke

Stroke is the fourth single cause of mortality in the UK and can lead to many complications. The risk of having a stroke doubles every decade after the age of 55. There are a wide range of risk factors for stroke, which includes lifestyle (e.g. smoking and alcohol use) and having conditions such as hypertension and atrial fibrillation (AF) (National Institute for Care and Excellence, 2017). Some of the high impact interventions in Table 3 will contribute to stroke prevention.

The risk of stroke increases five-fold for people with AF (Stroke Association, 2018a) (an ineffective heart beat in part of the heart muscle). The prevalence of AF increases with age (the prevalence in those over 65

years being 7.2 per cent, compared with 10% in over 75 years). In people who have had a stroke, concurrent AF is associated with a higher rate of mortality and greater disability. Approximately 60 per cent of people admitted to a hospital with a stroke caused by AF are not taking the recommended anti-coagulants. It is estimated that two thirds of AF related strokes can be avoided (Stroke Association, 2018b).

The East Midlands Clinical Network Networks (2018), has identified the number of patients in each Lincolnshire CCG who could have undiagnosed AF and those high risk AF patients who are not on anticoagulation (Table 3).

Table 3: CVD Prevention – Atrial fibrillation

	Stroke Admissions with Known AF (2014-15)	Number of Undiagnosed AF Patients (observed to expected)
Lincolnshire West CCG	87 (31.6%)	2006 (67%)
Lincolnshire East CCG	80 (20%)	2330 (71%)
South Lincolnshire CCG	62 (27.8%)	1449 (70%)
South West Lincolnshire CCG	20 (20.8%)	1092 (72%)

(Source: East Midlands Clinical Senate Networks, 2018)

# Ageing and Health: The Potential of Prevention

Healthcare professionals are continuing to ensure that people identified with AF are appropriately managed to reduce their risk of having a stroke. In 2016/17, the AF prevalence for all ages was 2.45%, representing nearly 19,000 people. The NHS Right Care Programme (NHS England, 2018) Stroke Pathway identifies

where Lincolnshire Clinical Commissioning Groups (CCGs) are in relation to their 'similar' CCGs on a number of indicators, including stroke prevalence and anticoagulation therapy. This includes a number of opportunities, for example increasing the AF found closer to the prevalence expected in our population

## Do the same or Do prevention? A comparison to 2035

In order to quantify better just how much potential there is in prevention, we can compare two possible options: the "do the same" option, and the "do prevention" option, and we can factor in the expected growth in Lincolnshire's population, as well as the projected change in the prevalence of these conditions over time.

By 2035, Lincolnshire's population is expected to grow to over 820,000 people, and the population aged

over 65 to over 243,000 (Office of National Statistics, 2017). We can also consider likely changes in disease prevalence, and use these to map the expected changes in the numbers in Lincolnshire with conditions that contribute to poor health in older age, all the way through to 2035 (Kingston, Robinson, et al., 2018).

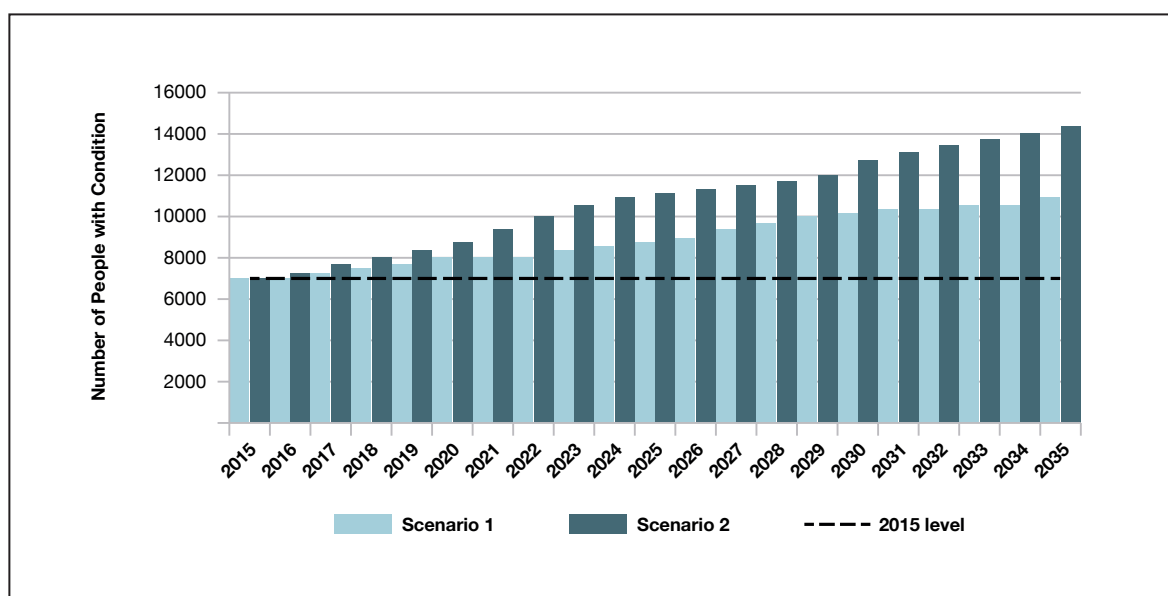
## What happens if we do the same?

If we do no more than we are doing now, the numbers of people living in Lincolnshire who have poor health in old age will increase in line with people's current experiences. If the proportion of people who have health conditions or impairments remains the same, the number of people living with these conditions will rise broadly in line with population growth. If the prevalence of these conditions increases as well (as is expected for

some conditions), the number of people in Lincolnshire with these conditions may rise even further than suggested by ageing alone.

Labelling the population growth only scenario 'scenario 1' and the population growth and prevalence change scenario 'scenario 2', in Figures 7, 8, and 9 show projections for some key conditions.

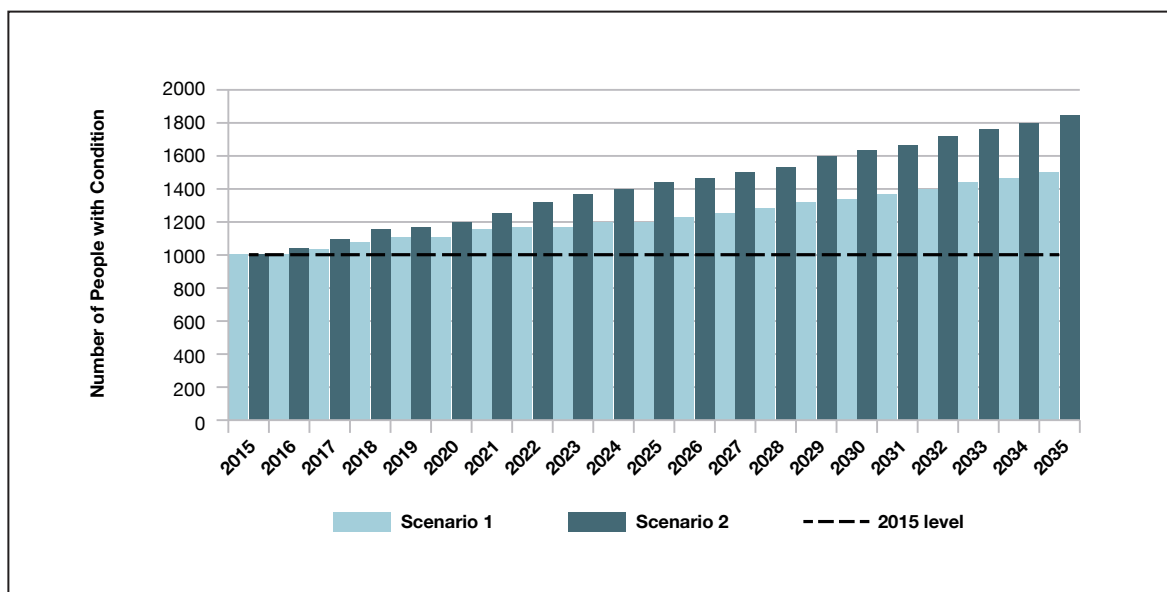
Figure 7: Projected growth in numbers of people in Lincolnshire with Arthritis, 2015 to 2035



(Source, Public Health England, undated) (ONS, 2017)

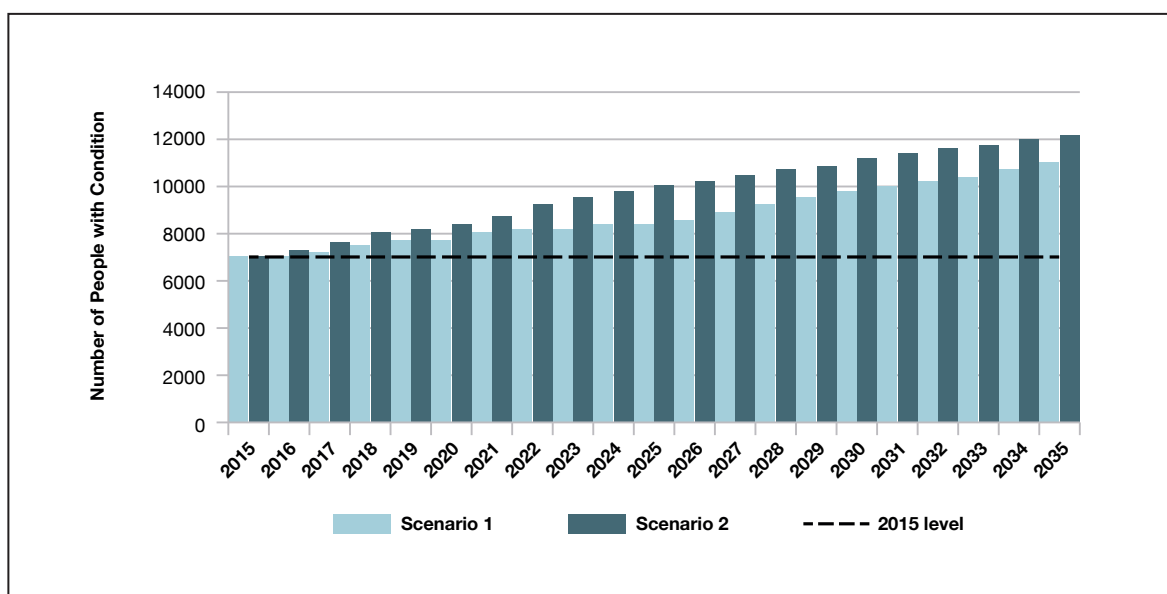
# Ageing and Health: The Potential of Prevention

Figure 8: Projected growth in numbers of people in Lincolnshire with Dementia, 2015 to 2035



(Source, Public Health England, undated) (ONS, 2017)

Figure 9: Projected growth in numbers of people in Lincolnshire with Hypertension, 2015 to 2035



(Source, Public Health England, undated) (ONS, 2017)

What we can clearly see from these projections is that if we do nothing, the number of people with poor health in older age in Lincolnshire will increase significantly. For example, the number of people with dementia could be expected to increase by 80% or more by 2035.

Additionally, the number of people who have a fall resulting in a hospital admission in Lincolnshire would

be expected to roughly double, to over 4000, by 2035. The cost to the NHS in Lincolnshire of these extra falls alone would equate to over £10m. The cost to the individuals, in terms of ill health and potential consequences such as loss of independence, would be far more significant.

# Ageing and Health: The Potential of Prevention

## What happens if we “do prevention”? Physical activity

Currently, the proportion of adults meeting recommended levels of physical activity in Lincolnshire is estimated at 65% (Public Health England, undated), although the prevalence of older people (over 75) who are active is thought to drop to 30% (British Heart Foundation, 2015). As Table 2 demonstrates, meeting

the recommend levels of physical activity equates to a significant reduction in lifetime risk for many conditions which affect older people. Table 4 details how a relatively modest increase in the proportion (just 20%) of 65s being physically active could affect the prevalence of key conditions in Lincolnshire.

**Table 4: Modelled reductions in key conditions following increase of 20% of over 65s becoming physically active.**

Condition	Over 65s expected to have condition in 2017	“Do Nothing” - Over 65s expected to have condition in 2035	“Do Prevention” –potential people with prevented disease if further 20% are active
Arthritis	88,658	159,961	3,414
Hypertension	87,335	136,308	17,069
T2 Diabetes	27,360	52,670	2,438
Stroke	13,471	22,677	5,803
Dementia	12,183	20,727	4,438

*(Source, Public Health England, undated) (ONS, 2017)*

The reductions in prevalence of key older age conditions available if an additional 20% of over 65s became physically active are significant, with an estimated reduction of 17,000 cases possible in hypertension

alone. Further increases in the proportion of older people who were active would further reduce the risk and increase the numbers of people who benefit from this change of lifestyle.

## Strength and balance for older age

As a further example, it has been shown that home-based strength and balance training can reduce the rate of falling in people participating by 29% (Public Health England, 2017a). If we apply these figures to the expected level of falls in 2035, we can see just how

many it is possible to prevent. Table 5 below gives these results, for this intervention as well as group-based training, and home assessment and modifications, and compares this to the ‘do nothing’ option.



# Ageing and Health: The Potential of Prevention

**Table 5: Falls interventions & projected reduction in emergency admissions due to falls in 2035**

Falls Prevention Intervention	Emergency hospital admissions due to falls expected in 2017	Emergency hospital admissions due to falls expected in 2035	Emergency hospital admissions prevented
Do Nothing	2,860	4,007	0
Strength & Balance Training - Group Therapy	2,068	2,845	1,162
Strength & Balance Training - Home Therapy	1,981	2,725	1,282
Home Assessment & Modification	2,359	3,246	761

(Source, Public Health England, undated) (ONS, 2017)

This case for this type of falls prevention intervention is clear, demonstrating that over 1,200 emergency admissions could be prevented in Lincolnshire in 2035, taking into account expected prevalence changes and population growth. The potential 29% reduction in the number of falls is available every year, and the cumulative

number of prevented falls could be as high as 25,000 over the 19 years modelled above. The economic case for action is clear as the potential cost to the NHS of implementing just one intervention proven to prevent falls (emergency hospital admissions) could be reduced by over £125m between 2017 and 2035.

## Conclusions and Recommendations

The age profile and predictions of changes in the overall proportions of our population in different age groups in Lincolnshire make it a place which might be described as having an 'Apocalyptic Demography'.

'Apocalyptic Demography' is a term used by social ageing experts to describe how statistics can be used to suggest that ageing is a significant threat to public services and the economy (Robertson, 1997; Gee, 2000). The primary nature of the risk described in the models that describe this is that, in a given population, the balance between the people who need support and the people able to provide it reaches a critical point.

In the case of our ageing population, this might be expressed as the ratio between older people in need of support and younger people in a position to provide support. This support might be physical in terms of family and carer support or economic activity like paying care fees or taxes to enable others to provide or fund support to older people.

A commonly used ratio of this type is the Old Age Dependency Ratio (OADR) and it is generated by simply dividing the number of people aged over 65 by the number of people aged 19-64 years. This ratio is, perhaps a deliberately simplified example of the problem with analyses which assert a generalised relationship between an easily measurable characteristic of a population (like their age at last birthday) and the whole of the population with that characteristic.

The OADR assumes, for example, that all people aged over 65 need support and all people aged 19-64 years are able to give support in the ways described above.

This clearly is not the case and different individuals and communities will be engaged in very different activities and have a range of different capabilities at the same age. It is clear, for example, that the rate at which different socio-economic groups of older people in a population who will be working will vary, with varying impacts on their health.

The apocalyptic demographic view of the UK and Lincolnshire populations that is prevalent in most planning models for health and care are often described as a given unless something is done to offset the tipping point in the ratio between those requiring care and support and those supplying it.

As differences in the disability and disease rates between different parts of the population, with different protective and preventative factors in play are evident, then it is clear that the likelihood of poor health in ageing is not immutable.

Finding the space and resources to invest in prevention activities at sufficient scale to make the return evident in the sustainability of a complex health and care system is challenging.

However, the evidence for doing so for now and the future for the benefit of our current and future older population is overwhelming. I therefore recommend that:

- 1. The Sustainability and Transformation Partnership should review its approach to planning and investing in those areas of preventative service where evidence of effect is irrefutable.*
- 2. That the Clinical Commissioning Groups (CCGs) should review the achievement and variation in clinical outcomes for people of all ages who have chronic diseases and commission activity to address inequities in said outcomes.*
- 3. That the County and District Councils should review their strategies for addressing approaches to the key protective and trigger factors the evidence base suggests support healthier ageing.*

# 1. Health Protection and Communicable Disease

## What is Health Protection?

The protection of the health of the population from known hazards, and the monitoring of health to identify emerging hazards, are cornerstones of public health. Health protection aims to prevent or minimise the harm caused by infectious (or “communicable”) diseases, as well as diminish the health impacts of non-infectious hazards, such as extreme weather and chemical exposures.

Communicable disease and environmental hazards can affect anyone and everyone, be that influenza or flooding. Reacting promptly and systematically to emerging incidents, and proactively monitoring and planning for future threats to public health, are crucial in protecting the people of Lincolnshire and beyond. Being vigilant and actively addressing issues in health protection is also of vital importance in reducing health inequalities. For example, we know that many communicable diseases are associated with socioeconomic disadvantage (Semenza, Suk, et.al. 2010). Some communities are also more vulnerable to health protection hazards, including children and the homeless (World Health Organisation, 2010) (Sommer, Griebler, et. al, 2010).

Specialist health protection functions are provided by Public Health England (PHE), which has a Health Protection Team dedicated to Lincolnshire who manage

a wide range of incidents, disease outbreaks and wider health protection issues. Additional support for health protection is provided by the four Lincolnshire Clinical Commissioning Groups (CCGs) (in particular, their federated Health Protection Team) and the Director of Public Health, who supports and provides local leadership for the local authority responses to incidents. The Centre for Radiation, Chemicals and Environmental Hazards (CRCE), also part of PHE, provide expert input in the management of chemical and environmental incidents. There are many national organisations that contribute to local-level health protection. For example, the Animal and Plant Health Agency (APHA) identify and control disease in animals and plants. The strong working relationships between local partners contributes to the success we continue to achieve in protecting health in Lincolnshire.

In this chapter, the main contemporary and emerging hazards faced by local people are described, along with the roles and activities of the Lincolnshire Health Protection Teams, and their partners, using recent examples to highlight how the population’s health is protected in practice.

## Communicable Disease

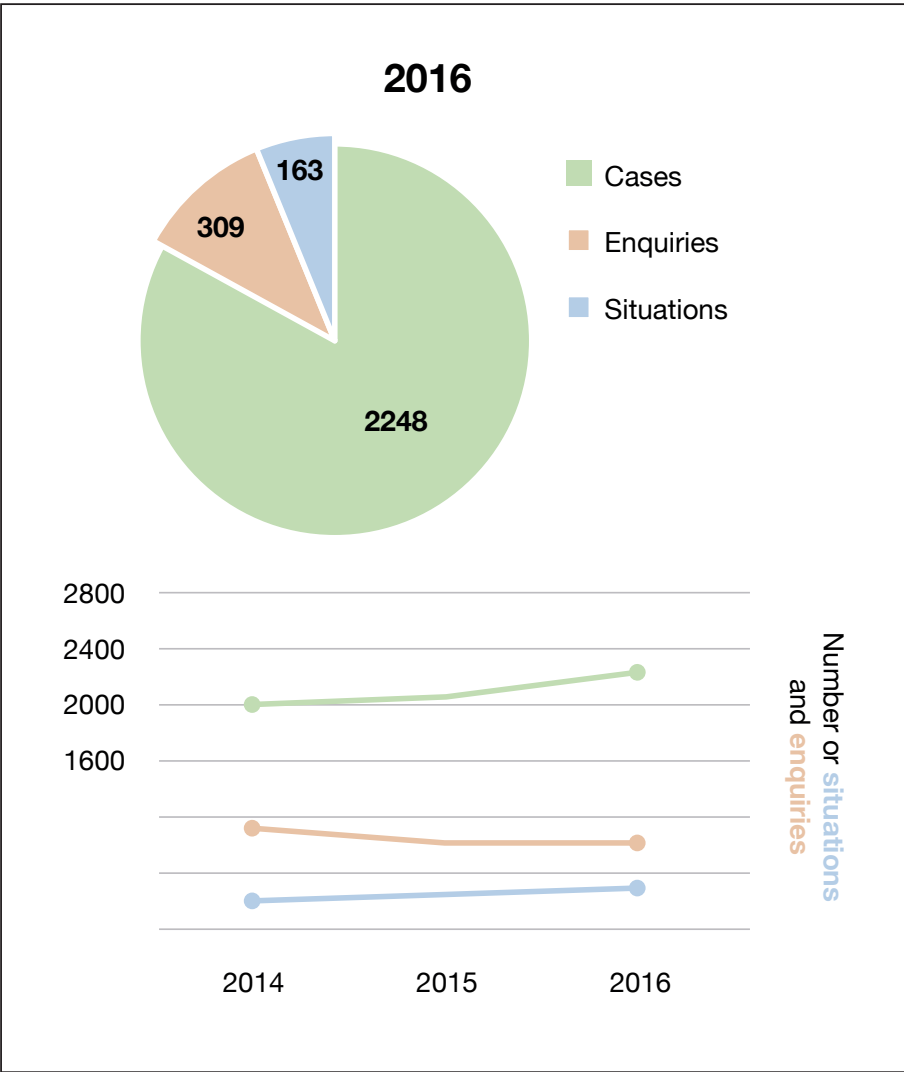
Much of the work done by the PHE Health Protection Team is based on individual cases, wider situations and incidents, or enquiries related predominantly to communicable disease. “Cases” are individuals with, or potentially with, a condition of relevance to health protection. Many of these cases are referred to the Health Protection Team by healthcare professionals who have a statutory duty to notify them of people suspected to have one of a list of 32 conditions, such as food poisoning, tuberculosis (TB), measles and meningitis (Public Health England, 2010). Situations are circumstances which either result in linked cases (such as an outbreak of food poisoning in a care home), or which may result in cases and thus require monitoring

(such as infectious contamination of a water supply line). Enquiries are received from a wide variety of sources, including hospitals, GP practices and the general public.

In 2016, the Health Protection Team managed 2248 individual cases of communicable disease in the county, for example advising people how to limit spreading an infectious disease, or providing vaccinations for those in contact with an infection to reduce the risk of transmission. They also responded to 309 enquiries, and dealt with 163 situations. These annual figures are fairly typical, with the numbers of cases, situations and enquiries remaining largely stable over the last few years (Figure 1).

# 1. Health Protection and Communicable Disease

Figure 1: Summary of workload directed towards the PHE Health Protection Team from Lincolnshire in 2016, and trends over 2014-16.



(Source: Data from HPZone)

## Summary of key communicable disease hazards

Food poisoning, which incorporates a variety of causes, encompasses over a third of cases dealt with. Other common cases include scarlet fever and hepatitis, as well as the vaccine-preventable conditions mumps and whooping cough. There were 13 declared incidents in relation to TB infection in Lincolnshire in 2016 – a disproportionately high number compared to areas of the country such as Leicester which have a much higher number of individual cases of TB. As well as outbreaks

of other infections, additional situations managed included potential exposure to chemicals, assessment of public health implications in relation to a decomposing whale carcass on the Lincolnshire coast, and localised water supply contamination. Here, some of the most common and important health protection hazards in relation to communicable disease are discussed. Other communicable disease hazards are described later on in this report.



# 1. Health Protection and Communicable Disease

## Viral Gastroenteritis and Food Poisoning

Of the 163 situations dealt with in 2016, 100 were outbreaks of gastroenteritis, and the number of such outbreaks has increased over the last three years. The majority of gastroenteritis outbreaks were due to suspected norovirus. Norovirus – also known as the winter vomiting bug – is a highly contagious viral disease that causes diarrhoea, vomiting and abdominal pain. It can be transmitted from person to person by ingesting contaminated food or water, as well as through the air or by touching contaminated surfaces. Symptoms can begin as little as 12 hours after exposure, and can last a few days. The elderly and the very young are at particular risk of dehydration. Because it is so contagious, cases in close settings frequently result in outbreaks, such as in care homes, childcare settings, restaurants and hospitals. Prevention of norovirus involves decontamination of surfaces and careful handwashing with soap and water, as alcohol-based disinfection gels are far less effective at eliminating the virus.

Food poisoning describes any illness that results from the ingestion of contaminated food, and it affects around a quarter of the UK population every year. Whilst food

poisoning frequently results in diarrhoea and vomiting, there are many possible bugs that can cause it, including salmonella, campylobacter and E.coli O157, as well as norovirus. Although food poisoning is usually self-limiting, the resulting absences from school and work have been estimated to cost the UK economy over £1.5 billion annually (Food Standards Agency, 2011). All cases of suspected food poisoning should be notified to PHE, and in Lincolnshire in 2016 there were over 600 cases of Campylobacter, almost 100 of Salmonella and 10 of E.coli O157 infection. The numbers of Campylobacter infections have been steadily reducing over the last three years, whilst the annual numbers of cases of the other infections have remained stable. By working in close partnership with Environmental Health Officers (EHOs) in local councils, the potential sources of food poisoning can be identified and eliminated. EHOs also play a crucial role in assessing, monitoring and implementing safety practices in premises that sell and serve food, helping minimise the risk of food poisoning to the local population.

## Hepatitis A

Hepatitis A – a virus that causes inflammation of the liver – is a relatively uncommon infection in the UK that is also spread by ingesting contaminated food or drinking water. Symptoms include abdominal pain, fever and jaundice, and these can be severe, lasting weeks or months. However, because hepatitis A is infectious for around two weeks before symptoms begin, and younger

children frequently do not have any symptoms, there is a risk of inadvertent transmission within households and the community. Hepatitis A has increasingly been the focus of disease outbreaks internationally, with three multi-country outbreaks being reported across Europe in 2016/17, affecting over 1000 people across 19 European countries.

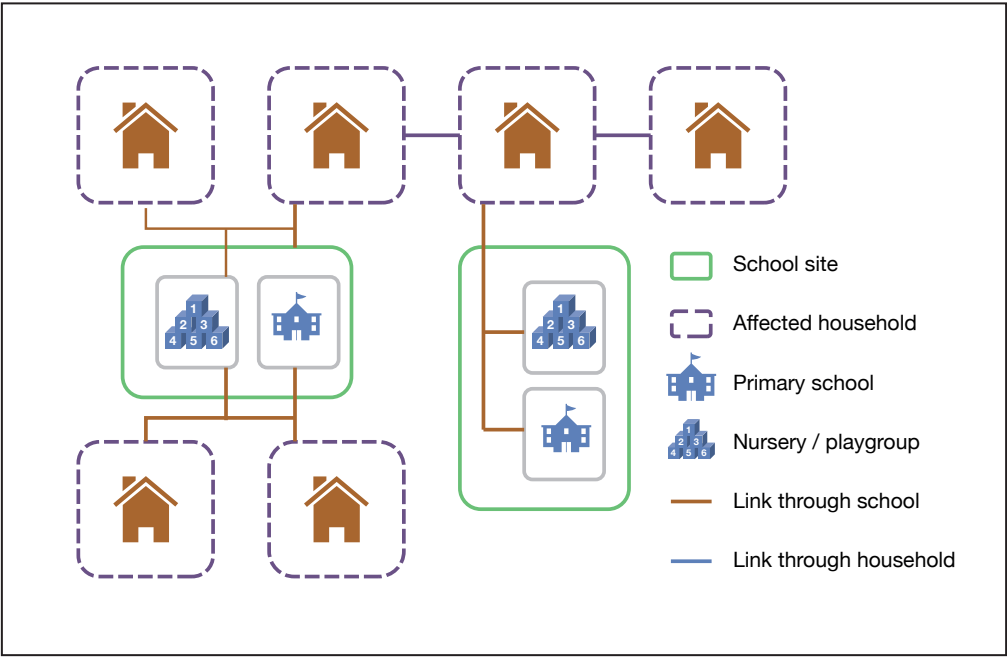
# 1. Health Protection and Communicable Disease

## Case Study – Hepatitis A Outbreak

In 2016, the Health Protection Team dealt with a cluster of cases of hepatitis A infection affecting people in 6 households in a single postcode area of Lincolnshire. By actively testing household members of the cases for infection, it was determined that some children did have hepatitis A infection without symptoms. In addition,

by identifying factors in common between the households, it was found that some of the families affected were known to each other. Furthermore, there were two primary school sites in common between the affected children (Figure 2).

Figure 2: The links between affected households in the 2016 Lincolnshire Hepatitis A outbreak



Based on this intelligence, several additional measures were taken in response to this outbreak. The Lincolnshire Health Protection Team led and co-ordinated the response while Environmental Health Officers from the local authority visited the two identified school sites to reinforce hand hygiene measures and suggest additional measures to minimise the risk of spread. Following advice from national experts at PHE, to actively reduce the risk of disease transmission in the two school settings, all children and staff were offered vaccination and were tested for infection using salivary swab tests. Following the receipt of consent, each individual was assessed on site by a local GP as safe

to receive the vaccine. The South Lincolnshire Clinical Commissioning Group (CCG) Health Protection Team were responsible for finding sufficient doses of the vaccine and for identifying healthcare staff to perform the vaccinations and salivary swabbing. In total, 681 children and 121 adults from the two school sites were vaccinated. Close contacts of those with confirmed hepatitis A were vaccinated by the GP practices.

Following these measures, there were no new linked cases of hepatitis A infection in the area. This outbreak was contained and managed successfully largely due to strong partnership working on a local and national level, along with a proactive vaccination strategy.

# 1. Health Protection and Communicable Disease

## Influenza

Influenza (or “the ‘flu’”) is an infectious disease caused by contagious influenza viruses, which are spread through the air by coughs or sneezes. Symptoms most commonly include a fever, sore throat, runny nose, headache, muscle ache and tiredness, and frequently last up to a week. Outbreaks of influenza can also occur in close settings, such as care homes, most frequently in the winter (Gallagher, Johnston, et. al. 2017). Whilst disease is usually self-limiting, it is potentially fatal in the very young, the elderly and in those with chronic health problems (Centres for Disease Control and Prevention, 2018). Vaccination is the best defence against flu. For people in defined high-risk groups (such as pregnant

women and young children), and for those working in health and social care settings, influenza vaccinations are recommended by the World Health Organisation. There are many strains of influenza viruses, and they have the ability to evolve rapidly. For this reason, new vaccinations are developed annually based on which strains of the virus are most likely to be circulating in the forthcoming year. For those that require vaccination, it is therefore imperative that these are received every year, to provide maximum protection. There were just over 100 cases of influenza in Lincolnshire in 2016, with two outbreaks of influenza-like illness in care homes.

## Case Study – Avian Influenza

Avian influenza (or “bird flu”) is caused by influenza viruses that infect wild and domestic birds. Some forms of the virus can affect humans – such as the H5N1 bird flu virus reported in 1997 – with symptoms including a high fever, cough, muscle aches, chest pain and diarrhoea. Avian flu is particularly relevant to Lincolnshire given the high density of poultry farms in the county. One particular strain of avian flu, known as H5N8, was described in 2008 and was first seen in the UK in 2014. Over the winter in 2016/17, 4 outbreaks of H5N8 avian flu were reported in flocks in Lincolnshire. Although avian influenza has the ability to cause disease in humans, there have been no reported cases from the H5N8 strain. However, there is the possibility that this strain could mutate and become infective in humans. Because of this potential risk of transmission to humans, a prompt and thorough Public Health response was required to the poultry outbreaks in Lincolnshire.

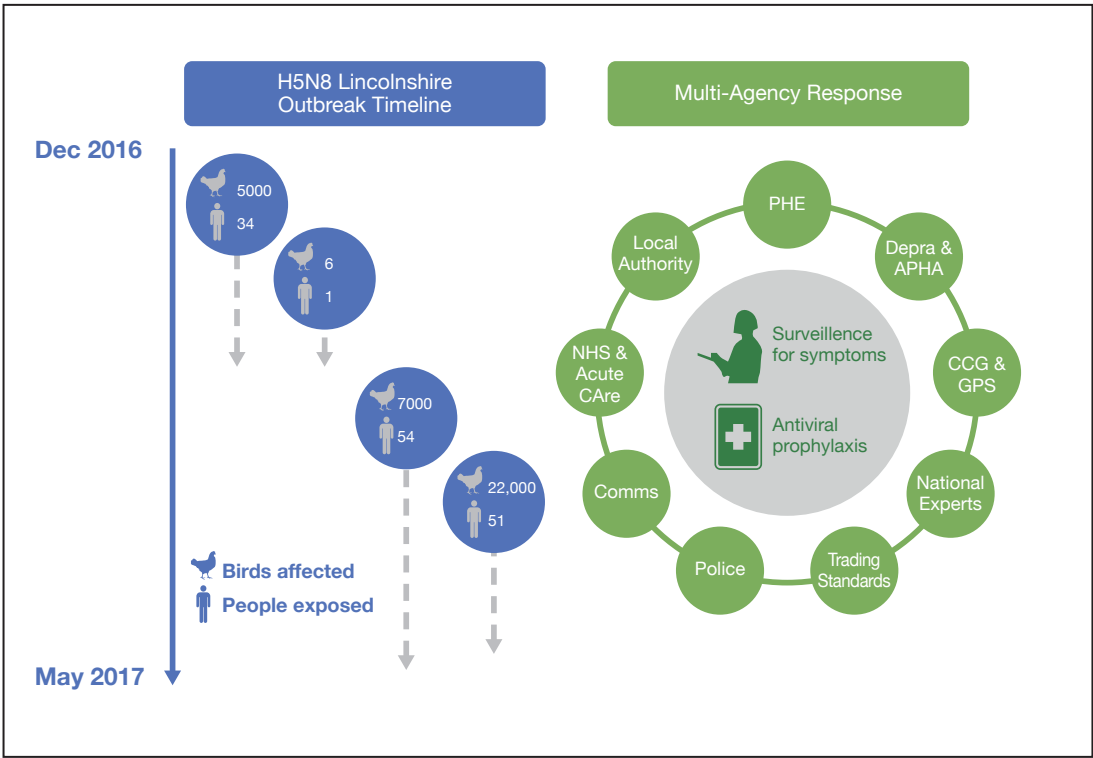
The first suspected outbreak was reported in a small flock on a weekday evening in December 2016, and a precautionary incident meeting was held the next day in order to plan the response. The day after, once the diagnosis was confirmed, PHE and CCG staff were deployed to two local sites to assess those who had been exposed to the sick flock and to distribute antiviral drugs to prevent infection. Ongoing active surveillance

provided by the Health Protection Team of the high-risk exposed persons was required in the form of daily direct one-to-one contact, in order that any symptoms of influenza were detected and acted upon early.

A further 3 outbreaks in flocks occurred over the subsequent 6 weeks, all requiring urgent diagnosis in the birds, prompt identification of exposed persons, regular surveillance of exposed persons for symptoms of influenza, and antiviral prescription where required (Figure 3). This response required collaborative multi-agency working. For example, the CCGs developed Patient Group Directions (written instructions for the supply and administration of medicines to specific groups of patients) to allow certain non-prescribing healthcare workers to dispense prescription-only antivirals for those eligible, thus improving efficiency of drug administration. The PHE Health Protection Team, with support from the CCG, led the human health response including daily surveillance, while the Animal and Plant Health Agency (APHA) led the overall response and managed issues relating to animal health, crucial in limiting spread to other birds and reducing the risk to human health. The National Infection Service Respiratory Diseases Department at PHE provided expert guidance throughout. Fortunately, no exposed persons developed confirmed H5N8 avian influenza.

# 1. Health Protection and Communicable Disease

Figure 3: Avian influenza outbreaks in Lincolnshire, 2016-17



(Source: Data from HPZone)

## Vaccine Preventable Disease

Vaccinations are biological preparations that provide immunity against disease. They are the most effective method of preventing infectious disease, and have been responsible for the eradication of smallpox and the restriction of polio. The UK immunisation schedule (Public Health England, 2017b), co-ordinated and commissioned by NHS England, provides comprehensive protection against a large number of potentially dangerous infections, helping save lives, prevent unnecessary illness and minimise the consequent costs to the healthcare system. The diseases protected against in the 2018 UK routine immunisation schedule are summarised in Figure 4.

NHS England are responsible for managing the routine immunisation programme, both nationally and locally. The programme in Lincolnshire is managed by the Central Midlands Screening and Immunisations Team.

For vaccinations to be maximally effective, a large proportion of the population need to receive them. This reduces the number of people who are susceptible to infectious disease and hence limits the spread of infections. This is known as herd immunity. Coverage of childhood immunisations in Lincolnshire is generally similar to regional averages, and above national averages, but below the benchmarks required for effective herd immunity. For example, for the first MMR vaccination dose given at 2 years of age, coverage in 2016/17 was 93.1% in the county, 93.6% in the East Midlands, and 91.6% across England. However, the goal is at least a 95% vaccination rate, and further work is being done by the Screening and Immunisations Team to improve vaccination uptake in Lincolnshire, and thus minimise the consequent risk to the population.



# 1. Health Protection and Communicable Disease

Figure 4: The diseases protected against by the UK routine immunisation schedule, from 2018.  
(Vaccines against the same / related diseases are shown in the same colour).

When to immunise	Diseases protected against
2 months	Diphtheria, tetanus, whooping cough, polio, <i>Haemophilus influenzae</i> type B, hepatitis B
	Pneumococcus
	Rotavirus
	Meningitis B
3 months	Diphtheria, tetanus, whooping cough, polio, <i>Haemophilus influenzae</i> type B, hepatitis B
	Rotavirus
4 months	Diphtheria, tetanus, whooping cough, polio, <i>Haemophilus influenzae</i> type B, hepatitis B
	Pneumococcus
	Meningitis B
12-13 months	Meningitis C, <i>Haemophilus influenzae</i> type B
	Measles, mumps, rubella
	Pneumococcus
	Meningitis B
2-8 years	Influenza (annually)
3 years and 4 months	Diphtheria, tetanus, whooping cough, polio.
	Measles, mumps, rubella
12-13 years (girls)	Human papilloma virus 92 doses, 6 months apart)
14 years	Diphtheria, tetanus, whooping cough, polio
	Meningitis A, C, W, Y
Pregnant Women	Whooping cough (given at 20 weeks gestation)
65 years	Pneumococcus
65 years and older	Influenza (annually)
70 years	Shingles

(Source: Patient UK, 2018)

# 1. Health Protection and Communicable Disease

## Measles

Measles is a viral illness whose symptoms include a cough, runny nose and a rash which spreads from the face to the whole body. Transmitted through the air when an infected person coughs or sneezes, measles is extremely contagious. The complications of measles can be serious, and include pneumonia, blindness, brain infection and death (Moss, 2017). Since the introduction of the measles vaccine – which is now combined with vaccines against mumps and rubella (MMR) – the number of recorded cases have dropped significantly from hundreds of thousands to hundreds. Following the widely publicised, but incorrect, claims surrounding the side-effects of MMR in 1998 (Bates, 2011), the proportion of children being vaccinated

against the disease dropped to 80% in 2003/4, and the numbers of cases and complications of measles increased significantly. Thankfully, vaccine uptake has been improving more recently, with catch-up campaigns run to protect those who were previously unvaccinated. Over the 5-year period to 2016, there have been 22 cases of confirmed measles in Lincolnshire – a rate far lower than the national figures – and annual numbers of cases have declined from 11 cases in 2012 to 1 case in 2016. Whilst these figures are encouraging, further work needs to be done to continue promotion of vaccination, with targeted approaches for those at high-risk for non-vaccination, including the travelling community and migrants.

## Whooping Cough

Whooping cough is a disease of the respiratory tract that is spread through the air by coughing or sneezing. Infection is characteristically associated with cold-like symptoms followed by bursts of coughing which can last several weeks. Whooping cough in babies is particularly risky, with infants prone to developing pneumonia. When a vaccination for whooping cough was introduced in the 1950s, infection rates dropped nationally. However, in 2012, an increase in rates was noted in infants under 3 months. In order to provide additional protection to this age group, in October 2012, whooping cough vaccination was introduced for pregnant women between 16 to 32 weeks, as part of the routine immunisation schedule. This protects

babies against whooping cough until they are old enough to receive their routine vaccinations at two months of age. This scheme has proved effective, with babies born to immunised mothers having a 90% reduction in their risk of developing whooping cough (Amirthalingam, Andrews et.al. 2014). In Lincolnshire, the annual number of confirmed cases of whooping cough in all age groups had steadily increased from 20 in 2014 to 100 in 2016. Some of this increase may be due to heightened awareness, with more testing done in suspected cases. A high coverage of the maternal immunisation programme needs to be maintained to provide protection to those who are too young to be immunised.

## Meningococcal Disease

Meningitis is an infection of the lining around the brain, often caused by bacteria. Symptoms include a fever and headaches, and infection is fatal in 5% of young children and 25% of older adults. Meningitis can also cause long-term disability, such as hearing and sight loss, and epilepsy. One of the common causative bacteria, known as meningococcus, can be particularly dangerous, and can cause both meningitis and septicaemia (infection in the bloodstream). Meningococcal septicaemia is associated with a characteristic rash, which does not disappear when pressing a glass firmly against it (the “tumbler test”). Transmission is from person to person via droplets in the air, or by direct sharing of respiratory or throat secretions (saliva). There are different types of meningococcus, including types A, B, C, W and Y (Public Health England, 2017c). Meningococcus

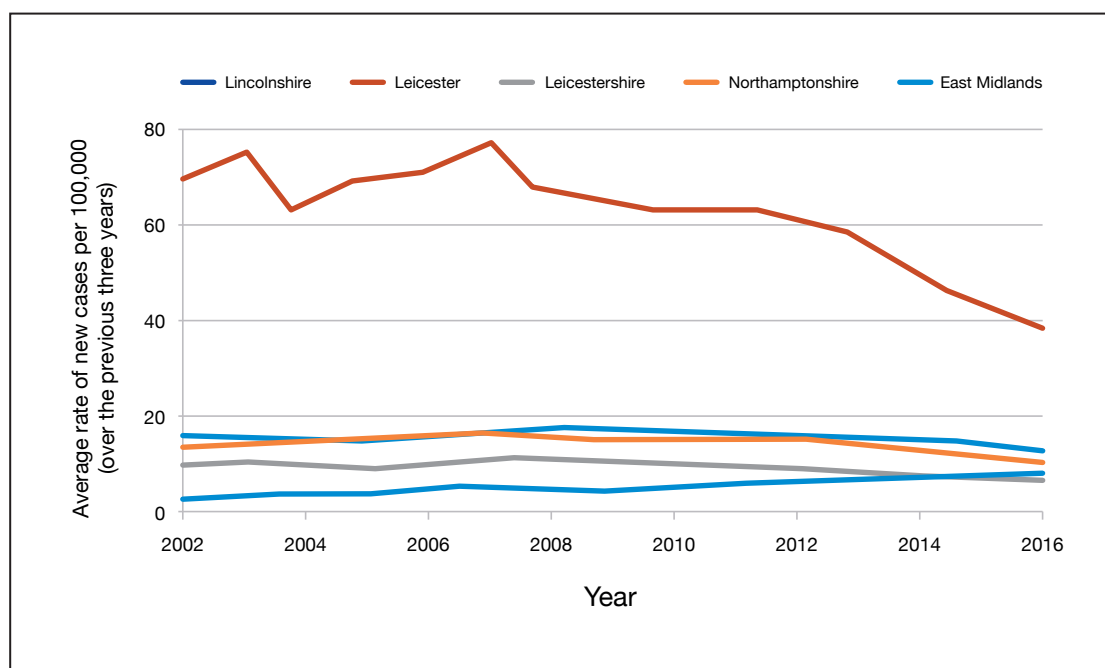
type C (MenC) vaccines were introduced into the UK immunisation schedule in 1999, and this has almost eliminated MenC in England. Since its introduction, however, there has been an increase in the number of cases of other types of meningococcal infections. In order to address this, a meningitis B vaccination was introduced into the routine UK immunisation schedule in 2015, along with an extension of the meningitis C vaccination to include types A, W and Y. In Lincolnshire in 2016, there were 9 confirmed cases of meningococcal meningitis or septicaemia – similar to the previous 2 years. The hope is that the widened protection from different types of meningococcus will reduce the frequency of cases of meningococcal disease in the coming years.

## 2. Tuberculosis

Tuberculosis (TB) is a bacterial infection that is transmitted through a prolonged exposure to infected respiratory secretions. Symptoms typically include a persistent cough, fever, loss of appetite and weight loss. Although it most commonly affects the lungs, TB can infect many other areas of the body, including bones, the brain and the abdomen. Treatment is vital to cure infection, and involves taking several antibiotics for 6 months or longer. The BCG vaccine is offered to at-risk persons, such as healthcare workers or children living in areas with high TB rates, to limit the risk of infection.

In 2016, there were 5664 new cases of TB identified across England, which equates to 10 new diagnoses per 100,000 people. There has been a gradual decline in TB diagnoses nationally over the previous few years, although within Lincolnshire case numbers have risen steadily year on year (Figure 5). In terms of absolute numbers of new cases, Lincolnshire compares favourably with an annual rate of 5 new diagnoses per 100,000 people – significantly lower than the East Midlands and the rest of England (Figure 6).

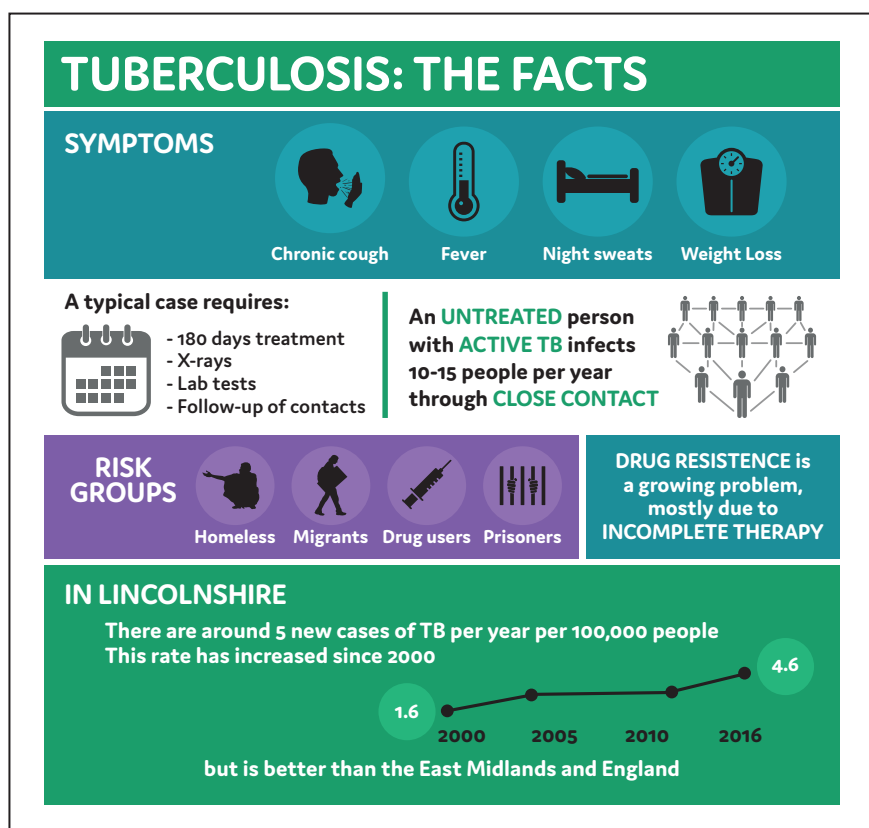
**Figure 5: Time trend showing the annual rate of new cases of TB per 100,000 population in local authorities in the South East Midlands, as well as the East Midlands overall. (Data for each year is calculated from the average of that year and the preceding two years.)**



(Source: Public Health England, undated)

## 2. Tuberculosis

Figure 6: Facts on Tuberculosis



Given the gradual rise in TB cases in Lincolnshire, our relatively low rate compared to national figures is not cause for complacency. There are specific challenges to be addressed in order to minimise the rate and adverse consequences of TB in the county. For example, despite the low rate overall in Lincolnshire, there are still a number of complex cases within specific at-risk groups in Lincolnshire, such as the homeless and other underserved populations. Indeed, nationally the rate of TB in the non-UK born population is 15 times higher than in the UK-born population, and it is 4 times higher in the most deprived compared to the least deprived (Public Health England, 2017d). A second, more widespread issue is that of drug resistance. Multidrug-resistant TB (MDR-TB) is a TB infection that does not respond to the most powerful anti-TB drugs. This makes treatment more difficult, expensive and prolonged. MDR-TB also disproportionately affects those in vulnerable groups. A further challenge is that of latent TB – where an

individual has the infection, but it remains dormant whilst at risk of reactivating. Work is being done nationally to screen recent entrants to the UK from countries with a high incidence of TB, in order to identify and treat latent TB infections before they become active and infectious.

The public health management of TB occurs on both local and national levels. An East Midlands TB Control Board was established in 2015 to strengthen the co-ordination and oversight of all aspects of TB control. This board includes representation from local authority, the CCG, NHS England, hospitals, research professionals and the voluntary sector, as well as from Public Health England. A local Lincolnshire TB Control Board also acts in the primary interest of the county, and provides representation to the East Midlands TB Board, working closely with them to deliver the national TB strategy. The work of these Boards in delivering sustained improvements in TB control is monitored through the evaluation of key indicators.

## 2. Tuberculosis

### Case Study – Tuberculosis

A child was diagnosed with TB infection in Lincolnshire. TB infection in children is unusual in this county and an incident meeting was held promptly to investigate both where the child may have acquired the infection, and assess the risk of infection to others. A multi-agency meeting was held and the decision taken that the county-wide TB service would investigate possible sources of infection by discussing potential exposures with the family. The nursery the child attended was also contacted and visited by the PHE Health Protection Team and the TB service to review any risk to others. It was identified that the child attended a number of classes but had not had close contact with all others in the nursery. The school worked closely with the health staff and provided details of all classmates and staff members who had been in contact with the case. These were then all offered screening. PHE Health Protection Team and the TB service also held a number of sessions with staff to discuss TB infection and answer their queries, as the process had highlighted a number of

anxieties. Unfortunately, there is still stigma attached to a diagnosis of TB, especially so in a county which does not have high numbers of cases.

Following screening of staff and children, no new cases were detected, and the Health Protection Team were able to reassure staff, children and parents.

The following year, a small outbreak of TB in children connected to a childcare setting occurred. This led to a large-scale screening exercise at a school – 383 individuals were invited for screening, of which 276 attended. The PHE Health Protection Team, the countywide TB service and the 4 Lincolnshire CCGs worked closely with the school to undertake this screening. Five cases of latent (non-infectious) TB infection were detected and the individuals successfully completed treatment ensuring prevention of further active (and therefore infectious) cases.

### Case Study – Mobile Find-and-Treat Service

A case study which demonstrates effective multi-agency working is the use of a mobile 'Find and Treat' facility. In both Lincoln and Boston there have been clusters of cases of TB in the vulnerable homeless populations. The cases themselves have been identified, diagnosed and had treatment to cure them of the infection. However, one aspect of health protection is identifying contacts of cases who may themselves be unknowingly infected and therefore present a potential risk to others. The homeless population prove challenging in terms of identification of the individuals exposed due to a number of lifestyle factors. Multi-agency incident meetings were convened by the PHE Health Protection Team resulting in the decision to use a London-based service to support contact screening. This service comprises a large NHS van which can be moved to any location in the country. The van contains a mobile X-ray machine and can process samples for rapid identification of TB bacteria. Staff from PHE, the CCGs, healthcare provider organisations, a number of charitable and community organisations, local authority staff and the police all contributed to ensure a large number of the vulnerable

groups in both Lincoln and Boston were screened and offered incentives for attending. During one of these events, 46 people had a chest X-Ray and 35 had blood tests that screen for exposure to TB. Following this screening, one active case and eight latent (non-infectious) TB cases were identified.

One particular male was invited for screening as he was a close contact of cases from an outbreak and had declined to attend all previous appointments for screening. He was of the same demographic as the outbreak cases, all of whom had waited until they were severely ill and eventually presented to the emergency department. All previous cases had required extensive hospital stays, either at tertiary facilities or in rehabilitation units, costing many thousands of pounds each. For this individual, detecting his infection early helped to prevent further onward spread of infection, avoided severe ill-health for themselves, and allowed him to be treated as an outpatient. In combination, these benefits would have also saved the NHS thousands of pounds.

### 3. Healthcare-Acquired Infections and Antimicrobial Resistance

#### Antimicrobial Resistance

Antimicrobials are substances that kill micro-organisms, such as bacteria, viruses or parasites. It is a broad term that encompasses antibiotics, which are drugs that specifically target bacteria. Antimicrobials are commonly used in healthcare to prevent or treat infectious diseases. Indeed, antibiotic use has been increasing over the previous few years, most likely due to longer courses and higher doses being prescribed. However, the more we use them, the more likely it is that infectious bugs evolve in such a way as to protect themselves from these agents. This is known as antimicrobial resistance (AMR).

Although antimicrobial resistance is a naturally occurring process, it is facilitated by the inappropriate use of antimicrobials, such as taking antibiotics for a cold or sore throat caused by viruses (Ventola, 2015). AMR threatens the effective prevention, control and treatment of infectious diseases, and is a global public health problem that requires action across all government sectors and society. As AMR becomes more widespread, we will have fewer effective antimicrobials to treat infectious diseases, which will subsequently pose a much greater risk to health. A lack of effective antibiotics would also compromise the success of major surgery and cancer chemotherapy. This issue is exacerbated by the lack of discovery of any new classes of antibiotic over the previous 30 years.

The cost of healthcare for patients with resistant infections is higher than care for those with non-resistant infections, due to a longer duration of illness, additional testing and the requirement for more expensive drugs. It is estimated that if AMR is not addressed, it will annually result in around 10 million deaths worldwide by 2050 – more than cancer – and cost the global economy £66 trillion (Figure 7) (O'Neill, 2014).

The UK has helped lead international efforts in tackling AMR, involving the World Health Organisation, the United Nations, and the G7 and G20 fora. Global acknowledgement of the risk of AMR came in September 2016, when 193 Member States adopted a UN Declaration on AMR. The UK's own review of AMR, published in 2016, resulted in a number of commitments by the government (Department of Health and Social Care, 2016). These included creating a global approach to funding the development of new antimicrobials, promoting research into new vaccines to prevent disease, improving the speed of diagnostics, enabling better prescribing, and promoting understanding and awareness of AMR. These responsibilities are being led by a variety of institutions, including Public Health England, the Department of Health, Department of

Food and Rural Affairs (DEFRA), NHS England, and the Medicines and Healthcare Products Regulatory Agency. For example, Public Health England advised the NHS on incentivising the reduction of antibiotic prescriptions in GP practices – a system which has now been implemented, as described below.

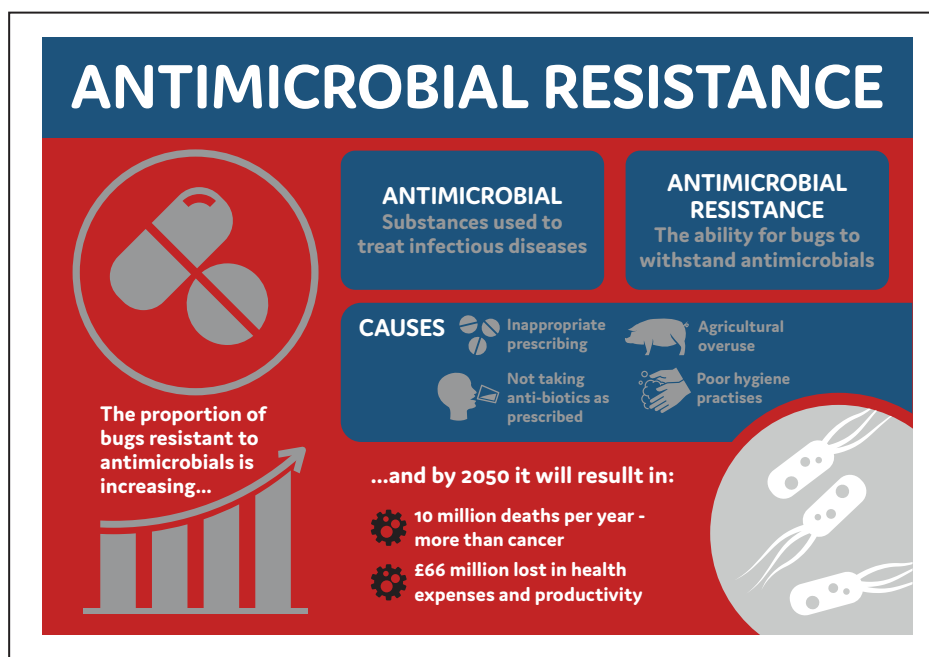
Within Lincolnshire, and across the East Midlands, there is a strong collaborative network that works to drive improvements in antimicrobial prescribing and reduce antimicrobial resistance. Co-ordinated by Public Health England East Midlands, the network is involved with proactive and reactive work. Examples of proactive activities include regular reviews of the local data around AMR, conducting audits, and using the results of these to identify issues and inform action. Reactive work in AMR includes support in disease outbreaks. The AMR network also inputs into education and training, including the provision of AMR-focused events, to promote understanding and responsibility around antimicrobial prescribing.

Improving antimicrobial prescribing practices across the NHS is a difficult task, especially when there is patient demand. In order to help health practitioners, systems are now available to allow individual GP practices to see data on their own antimicrobial prescribing practices, and compare these to local and national prescribing rates. Similar data are now being collected for hospital Trusts, looking at antimicrobial prescribing, levels of resistance, and antimicrobial stewardship (defined as strategies focusing on the responsible management of antimicrobial use). Since data started being collected in 2017, the average amount of antibiotic prescribing to admissions at United Lincolnshire Hospitals NHS Trust has been about 15% lower than the rest of England. Whilst this is encouraging, this may be due to wider factors, including the type of cases seen at the Trust and the general health of Lincolnshire compared to England as a whole. Other indicators for AMR in Lincolnshire are positive, too. For example, almost 98% of hospital antibiotic prescriptions were reviewed within 72 hours in the first quarter of 2017/18 (an indicator of good antimicrobial stewardship), compared to 90% across England. The proportions of E.coli bloodstream infections that are resistant to common antibiotics are also lower compared to other areas of the country. For example, 6-8% of E.coli bloodstream infections in Lincolnshire were resistant to the cephalosporin class of antibiotics, compared with 13% across the UK. Whilst data like these are encouraging, the trends of antimicrobial prescriptions over time will provide a more useful measure of whether prescribing practices are improving, and this will be followed closely.



### 3. Healthcare-Acquired Infections and Antimicrobial Resistance

Figure 7: Antimicrobial resistance.



#### Healthcare-Associated Infections

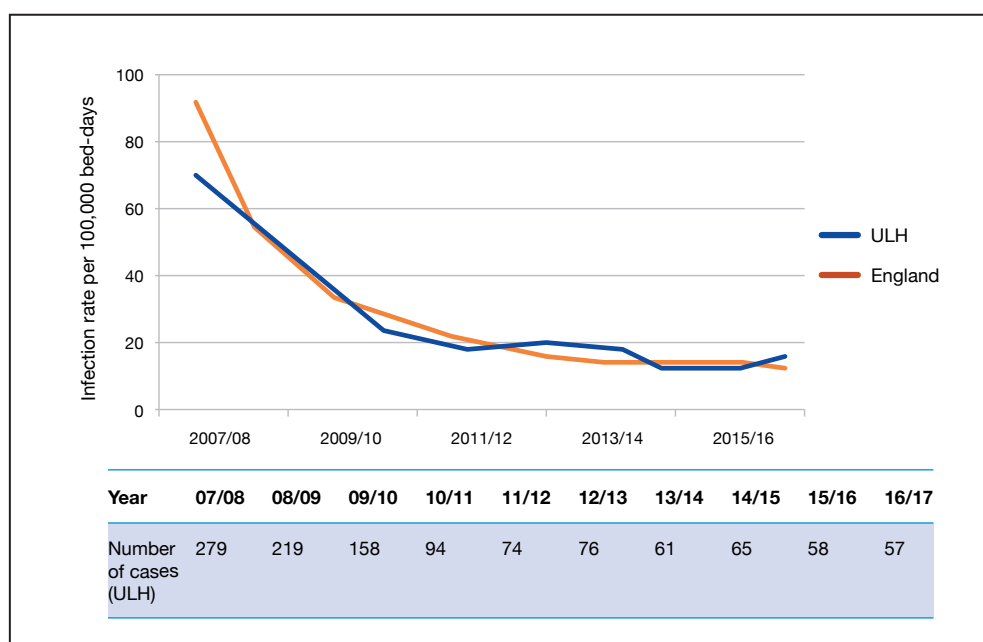
A healthcare-associated infection (HCAI) is one that is acquired during the process of care in a hospital or other healthcare facility, and that was not present at the time of admission. HCAIs can occur anywhere in the body, but most commonly affects the gastrointestinal and respiratory systems, and the urinary tract. Common infections that result in HCAI include methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile* (C.diff) and *Escherichia coli* (E.coli). HCAIs are a risk for both patients and staff, and can result in significant morbidity and mortality in those infected. Across Europe, around 25,000 people die each year from hospital-acquired infections (European Centre for Disease Prevention and Control/European Medicines Agency, 2009).

During the 1990s, increasing reports of MRSA across the UK led to the introduction of mandatory surveillance of this bacterium. The use of this data, followed by a zero-tolerance approach and a system wide drive to reduce MRSA, has resulted in a consistent decline in the rate of infections from its peak in 2005. In the financial year 2016/17, there were just 232 cases of MRSA bloodstream infections in England and Wales, compared to 450 in 2013/14. The annual number of deaths has also significantly declined. An encouragingly similar trend was seen in Lincolnshire, with no MRSA infections reported in 2016/17, compared to 5 infections in 2013/14.

Another more recent example of a HCAI is C.diff – a bacterium that can be found in the gut of healthy people, and which normally causes no harm. However, some antibiotics interfere with the natural balance of bacteria in the intestine by destroying those bugs which usually prevent C.diff from multiplying. If this occurs, C.diff multiplies rapidly and produces toxins which attack the intestine, resulting in fever, diarrhoea and abdominal pain. The toxin-induced bowel inflammation can be life-threatening. Like for MRSA, evidence-informed actions and a zero-tolerance approach have started to have an effect in reducing the numbers of C.diff infections. In 2016/17, there were 57 cases of C.diff infection in United Lincolnshire Hospitals NHS Trust, giving a rate of around 15 infections per 100,000 bed-days. This is similar to the average rate across the East Midlands and in England. Over the previous decade, there has been a steady decline in the rate of C.diff infections – both locally and nationally (Figure 8). It is likely that C. diff infection rates reach a plateau rather than disappear completely, as recent research suggests that not all cases of infection are hospital-acquired (Eyre, Cule, et. al. 2013).

### 3. Healthcare-Acquired Infections and Antimicrobial Resistance

Figure 8: Rates of C.diff infections per 100,000 bed-days over the previous decade in United Lincolnshire Hospitals NHS Trust (ULH) compared to national rates. (Absolute numbers of cases in ULH are shown in the table below.)



(Source: Public Health England, undated)

A third HCAI which is gaining more recent focus is E.coli bloodstream infection (BSI). This has been highlighted as particularly important as rates of infection are rising nationally, and the organism readily acquires resistance. Furthermore, E.coli is the most common cause of bacterial bloodstream infection. E.coli can enter the blood from many sources, but is most commonly secondary to urinary tract infections (40%), liver or biliary tract infection (11%) and the gastrointestinal tract (5%) (Bou-Antoun, Davies, et. al. 2016). Cases of E.coli BSI may be acquired in hospital or in the community (out of the healthcare service), with around two-thirds of cases being community-acquired. A recently published study of UK data found that of 28,600 E.coli BSI infections examined from 2011/12, there were over 5000 deaths, with 18% dying within 30 days of hospital admission overall (Abernethy, Johnson, et.al. 2015). To put this into context, that is over four times as many deaths as the highest ever single-year death tally from MRSA. Deaths were more common in males, the elderly and in cases which began in hospital. Cases caused by bacteria that were resistant to the most commonly used antibiotic had a 30% increased risk of mortality.

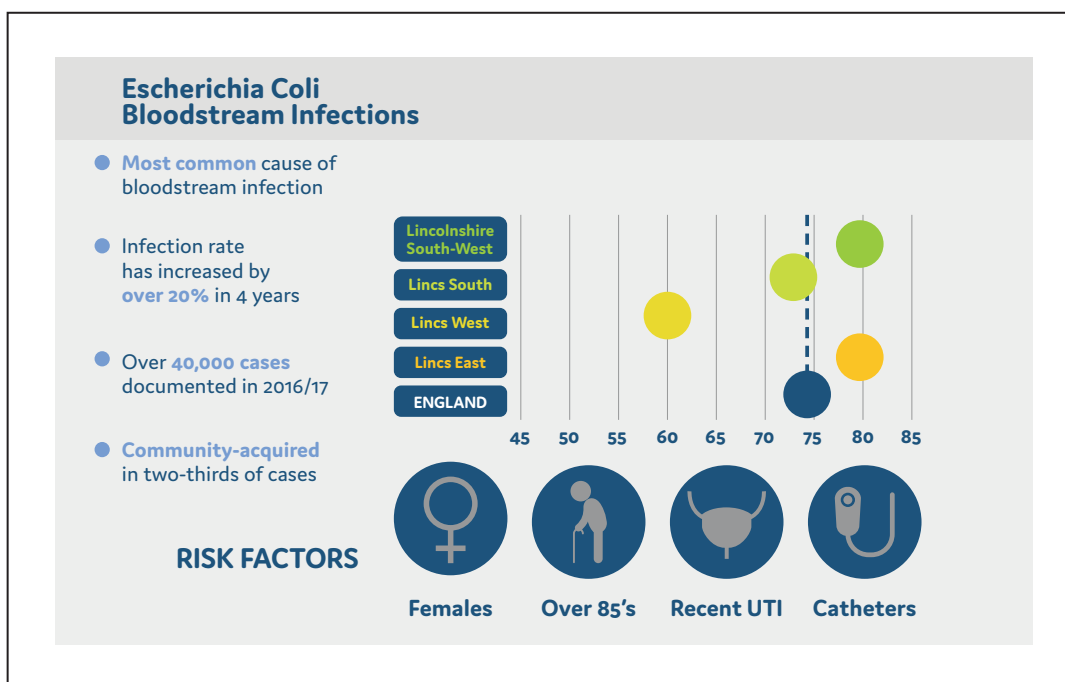
Across England in 2016/17, there was an average of 74 cases of E.coli BSI per 100,000 population. There was some variation within Lincolnshire, from a rate of 60 per 100,000 in Lincolnshire West CCG to a rate of 79 per 100,000 in Lincolnshire East CCG (Figure 9). This may be partly due to the differences in the proportion of older people in the CCGs. The rates of E.coli BSI across

the country also appear to be linked to deprivation, with higher rates amongst the most disadvantaged. Surveillance in the UK has demonstrated that there have been year-on-year increases in the numbers of people with diagnosed E.coli BSI, from 60 cases per 100,000 in 2012/13 to 74 cases per 100,000 in 2016/17.

This increase has been cause for some concern, and the Secretary of State for Health has recently set a challenging target of reducing the number of E.coli bacteraemia infections by 50% by 2020. More work needs to be done to ascertain the different causes and risk factors for E.coli bacteraemia, and to develop and assess innovative interventions that can help reduce the number of infections. The target is an important one from a patient safety perspective, and allows an opportunity for our local Health Protection Team to work with national experts at PHE, the Department of Health, GPs, Clinical Commissioning Groups and Acute Trusts, towards a common goal. Within the East Midlands, various providers and commissioners work in partnership to share good practice. Each healthcare provider, such as the Acute Hospital Trust, Community Health Services Trust, and the Mental Health Trust, has their own internal Infection Prevention and Control (IPC) meetings to review data and information. Within Lincolnshire, individual provider and commissioner representatives also meet at county-wide Whole Health Economy IPC meetings, which Public Health England attend and vice chair.

### 3. Healthcare-Acquired Infections and Antimicrobial Resistance

Figure 9: E.coli bloodstream infections



### 4. Emerging Diseases

#### What is an emerging disease?

An emerging infection is one which has either newly appeared in a population, or one that has previously existed but become rapidly more common or widespread. This could be, for example, an infection that has spread to new geographical areas and populations, or the re-emergence of an old infection that has become resistant to treatment. A range of emerging infectious disease have been identified over the previous few decades, including SARS (severe acute respiratory syndrome) and new variant Creutzfeldt-Jakob disease (which causes “mad cow disease”). Most emerging infections are zoonoses – meaning that they are diseases that are known to affect animals, but that transmission can occur between animals and humans. The emergence of new infectious diseases is unpredictable, but they could become more frequent due to a number of factors, including climate change, increased world travel and better systems for detecting new diseases.

A major risk of emerging infectious diseases is their potential to become pandemics – affecting large

numbers of people across many countries, or even worldwide. They are therefore a threat to global health security. The “swine flu” pandemic of 2009 caused over 18,500 deaths globally, and the historic pandemic influenza of 1918 (“Spanish flu”) killed over 50 million people worldwide. Whilst it is difficult to predict the impact of an emerging infection, the rapid spread of such an infection may have a considerable effect on services in Lincolnshire and across the UK, such as on health and education, with economic disruption. The UK National Risk Register of Civil Emergencies summarises the likelihood and potential impacts of a range of risks over the next 5 years, including natural hazards and malicious attacks (Cabinet Office, 2017). In 2017, emerging infectious diseases were assessed as being moderately likely with a moderate impact – a similar risk as air pollution, and an increase in risk compared to the previous assessment in 2015. Robust action plans have been developed in order to minimise the risk of outbreaks of emerging infections, should such a threat present itself in the future. Two recent examples of emerging infections are described below.

## 4. Emerging Diseases

### Ebola

Ebola is a viral infection thought to be carried by fruit bats which can be transmitted to, and spread between, humans by the direct contact with infected blood or bodily fluids. Symptoms include a flu-like illness, chest and abdominal pain, headaches, a rash, and internal and external bleeding (Figure 10). The fatality rate is around 50%. Between 1976, when it was first identified near the Ebola River in the Congo, to 2013, there were fewer than 2000 confirmed cases. In 2014, an epidemic arose in 3 West African countries – Guinea, Sierra Leone and Liberia – infecting almost 29,000 people and causing over 11,300 deaths. It was declared a public health emergency by the World Health Organisation. The UK contributed to the international effort in managing the epidemic by leading the international response in Sierra Leone; sending staff from the NHS, military and aid organisations; establishing Ebola treatment centres through the Department for International Development; training local healthcare workers; and committing over £400 million to ending the epidemic.

As an additional control measure, to ensure early diagnosis and prevent disease spread, PHE led and co-ordinated a response to ensure travellers from Ebola-affected countries were screened. At UK airports and the Eurostar terminal at St Pancras, passengers who had recently travelled to Liberia, Guinea and Sierra Leone had their temperature measured and completed a questionnaire to determine their risk of infection. Based on these results, there were the options of a further clinical assessment by Public Health England staff, and

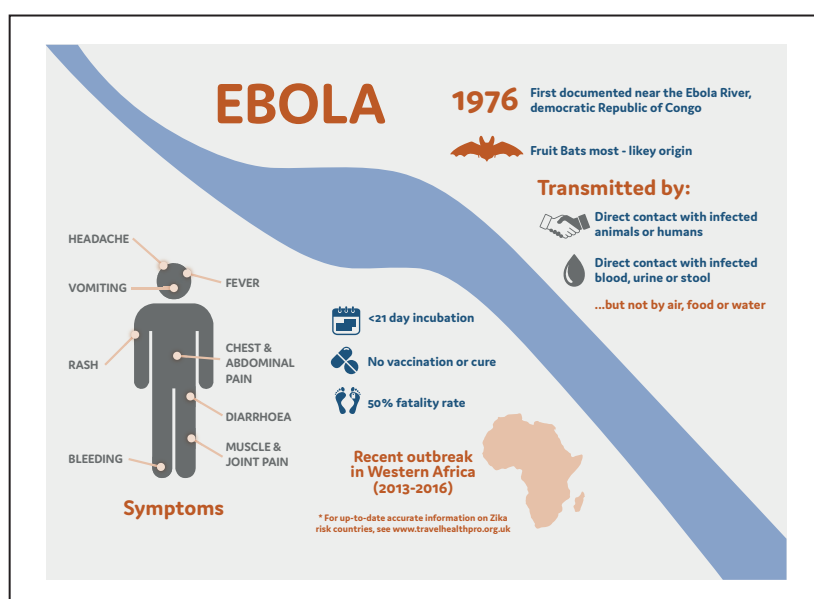
transfer to hospital for testing. Individuals who had no symptoms of Ebola, but who potentially could have contracted the virus, were closely monitored for 21 days (the disease's maximum incubation period). This included a number of Lincolnshire residents.

Public Health England produced a wide range of guidance documents to inform and advise professionals and the public (Public Health England, 2015). These cover all aspects of Ebola, including prevention and management in primary care and hospitals, diagnosis, assessing risk in prisons and immigration centres, screening people in airports, and disposing of potentially contaminated waste.

During the epidemic, there were only 3 confirmed cases of Ebola in UK residents – in healthcare and military staff who had volunteered in Sierra Leone. Only one of these was newly diagnosed in the UK. Although no one in Lincolnshire had acquired Ebola, plans and policies were in place for the appropriate management of suspected cases, to identify potential contacts, and to implement a range of control measures.

The Ebola epidemic was declared over in early 2016, and the ongoing risk to the UK public remains very low. A look-back exercise has been carried out to inform future actions and improve preparedness. Some of the learning from this includes the need to invest in vaccine development for potentially catastrophic epidemics, and the proposed development of a High Consequence Infectious Disease programme between Public Health England, the NHS and the Department of Health.

Figure 10: Ebola



## 4. Emerging Diseases

### Zika

First identified in the Zika forest in Uganda in 1947, the Zika virus is known to circulate at low levels in Africa and Asia in humans, animals and mosquitoes. Only a few outbreaks were noted before 2015. In May 2015, the first Brazilian case was documented. Since then, Zika infection has been reported in many countries in South and Central America, the Caribbean, South-East Asia and Oceania (Figure 11). Zika infection is usually mild and self-limiting, although the majority of infected individuals develop no symptoms. Symptoms include fever, headache, joint pain and a rash that lasts for less than seven days. The major complication of the Zika virus is infection during pregnancy, which can result in brain malformations in the unborn child.

The Zika virus is transmitted by the mosquito *Aedes aegypti*. This mosquito does not live in the UK, so cases seen here are almost exclusively associated with travel to areas with active Zika virus transmission. Public Health England run a mosquito surveillance scheme using mosquito traps to monitor the population dynamics and species distribution across the UK.

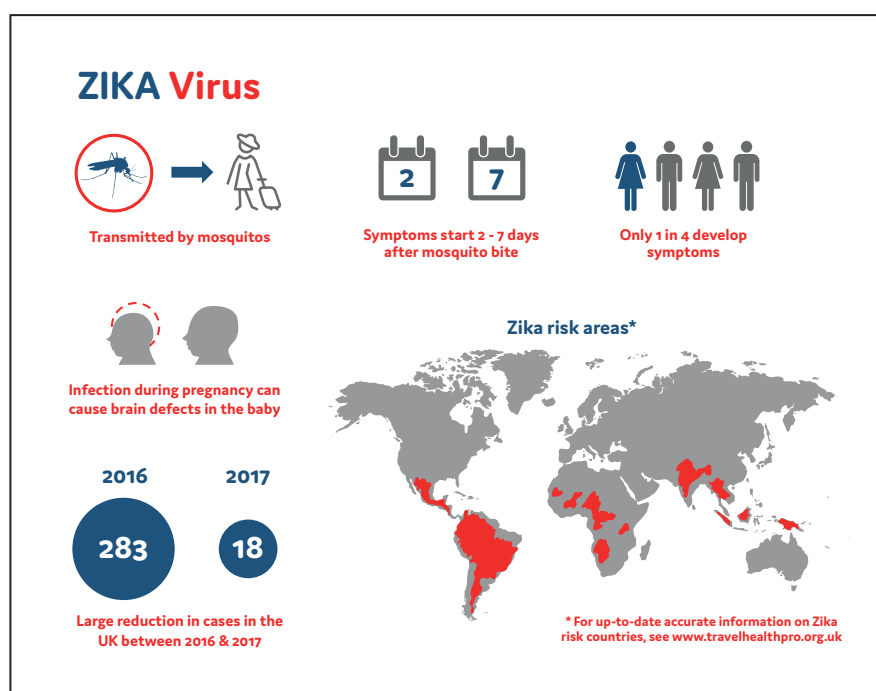
In 2016, there were 283 cases of Zika infection in the UK, of which 7 were in pregnant women. All but one were associated with foreign travel (with the other case being sexually transmitted). From January to November 2017, there were 18 cases of Zika infection – far fewer

than the previous year – and may in part be due to advice given to those considering travel to Zika-affected areas. Less than 5 cases of Zika infection have been noted in Lincolnshire, all following travel abroad.

The advice from Public Health England is based on the primary concern of avoiding infection during pregnancy. Pregnant women are advised to avoid non-essential travel to Zika-affected areas, and other travellers should follow published bite-prevention advice. Detailed travel health advice is hosted by the National Travel Health Network and Centre (NatHNaC) website (National Travel Health Network and Centre, 2017). To minimise the risk of sexual transmission of the disease, all males should use barrier contraception for 6 months following return from travel to Zika-affected areas, as the virus can live in the semen. Women should avoid conception for 8 weeks after returning from travel. Unfortunately, there is currently no vaccine or specific treatment for the infection (Public Health England, 2017e).

Public Health England have also published guidance for healthcare professionals to aid in the assessment and management of pregnant women and babies with potential Zika infection. These have been developed in collaboration with other medical professional bodies, including the Royal College of Obstetricians and Gynaecologists and the Royal College of Midwives.

Figure 11: Zika virus



## 5. Chemical And Environmental Hazards

### Summary of Key Chemical and Environmental Hazards

Environmental public health incidents often require an integrated response from several Centres within PHE. The Centre for Radiation, Chemical and Environmental Hazards (CRCE) works in partnership with Health Protection Teams, along with Communications and Emergency Planning teams, to provide expert advice and support to a range of stakeholders during acute and longer-term environmental incidents which have the potential to threaten health. Such incidents could involve fires, chemical contamination of the environment (air, water, land), or exposure to chemicals and poisons, including deliberate release.

CRCE reviews the evidence base and produces position statements and resources for contentious facilities, such as energy-from-waste incinerators, shale gas and landfill sites, and establishments storing or handling large

quantities of hazardous industrial chemicals – known as COMAH (Control of Major Accident Hazards) sites. CRCE also performs similar functions for common incident types, including protracted fires.

PHE works closely with the Lincolnshire Resilience Forum to ensure suitable and effective multi-agency emergency preparedness for potential major incidents, including at upper-tier (higher risk) COMAH sites, high-risk waste sites and Major Accident Hazard Pipelines (which include high-pressure natural gas supply pipelines, as well as pipeline systems transporting oils, chemical and other gases). PHE provides expert responses to consultations on significant facilities or infrastructure development and can provide impartial support to public engagement and public meetings.

### Case Study – sulphur mustard incident in Lincolnshire

PHE was alerted on the 3rd October, 2017 to an incident involving a member of the public who had potentially been exposed to sulphur mustard (i.e. mustard gas) in Lincolnshire. Six small canisters were found in a forested area nearby to a former military base. Two canisters were originally discovered and disturbed, but these were likely part of a wider cache. A Strategic Co-ordination Group – whose function is to co-ordinate multi-agency

responses during major events – was called to direct the safe management of this incident, and to ensure appropriate investigation and decontamination. In total, 150 canisters of sulphur mustard were uncovered. PHE provided expert advice and contributed to the multi-agency communication process and dynamic risk assessments.

### Air Pollution

Air pollution impacts on public health, the natural environment, and the economy. Poor air quality is the largest environmental risk to public health in the UK (Holgate and Stokes-Lampard, 2017). It is known to disproportionately affect vulnerable groups, for example the elderly, children and people already suffering from pre-existing health conditions, such as respiratory and cardiovascular disease (Sacks, Stanek et.al. 2011). PHE facilitate the East Midlands Air Quality Network, a cross-disciplinary network which includes professionals from Public Health, Environmental Health professionals, and spatial and transport planners. This network

encourages collaborative working at a regional scale and the sharing of best practice, with the aim of reducing air pollution impacts and inequalities, and ensuring health is considered at an early stage in policy and intervention development. CRCE supports PHE within the East Midlands by providing expert scientific advice to Air Quality Cells (quick-response teams that co-ordinate air quality monitoring in major pollution incidents), Scientific and Technical Advice Cells (who provide co-ordinated scientific and technical advice during the response to an emergency) and other multi-agency meetings.



## 5. Chemical And Environmental Hazards

### Surface and Coastal Flooding

Flooding can result in loss of life, damage to buildings, travel disruption and dangers from fast-flowing water. It can also result in indirect effects, such as difficulties in access by emergency services, and adverse mental health effects in those who are subsequently displaced (Munro, Kovats, et al., 2017) Lincolnshire has a large fluvial (river) and tidal floodplain, covering almost 40% of the county. In order to minimise the risk of flooding, this floodplain almost entirely relies on manmade defences, such as walls, embankments and pumping stations. A number of main rivers pass through urban areas of the county, such as the River Trent and the River Witham, putting around 18,000 properties at risk from fluvial flooding. Flooding can also result from excessive rainfall, such as surface water flooding, which occurs when rainfall exceeds the capacity of piped drainage systems, or as a result of overland flow following intense rainfall. Lincolnshire County Council is the Lead Local Flood Authority, and thus is the lead responding agency in surface water flood incidents, as well as being responsible for assessing, mapping and planning for local flood risk.

The annual chance of flooding to coastal communities in Lincolnshire is estimated to be between 0.5% (1 in 200) and 2% (1 in 50). This risk is low largely due to

man-made defence systems. Whilst the probability of coastal flooding is low, this risk is likely to increase with climate change, which is predicted to result in a rise in the sea level by 1 metre over the next 100 years. Much of the land behind tide defences in Lincolnshire is below average sea level, and extends up to 10km inland, forming the largest single area at flood risk in the country. The consequences of a severe tidal surge are therefore potentially high. The Environment Agency are responsible for coastal flood defences (as well as main river defences), and thus work in partnership with Lincolnshire County Council as lead responders for flooding incidents.

Comprehensive response plans have been developed in order to address the potential risks of coastal and inland flooding. These plans are based on local risk assessments which suggest a moderate risk of flooding in the county, with a potential impact ranging from local disruption to travel, to possible damage to buildings. Three key strategies are encompassed within such response plans. These are: (a) pre-deployment of assets where there is some warning time, such as national flood rescue services; (2) the removal of people from danger, including preventative evacuation; and (3) the protection of local infrastructure and essential services.

## Conclusions and Recommendations

There is evidence and assurance of effective systems being in place to monitor known hazards to health in Lincolnshire. The participation of our health systems in national and international systems of surveillance gives some assurance that new and emerging threats would be identified, investigated and mitigated where possible.

However, I ask that the organisations responsible for protecting the health of local people consider the following recommendations:

- 1. The Health Protection Board, Clinical Commissioning Groups (CCGs) and Healthcare Providers continue to innovate to promote the uptake of immunisation and vaccination programmes across our entire population.*
- 2. The Health Protection Board, CCGs and Healthcare Providers provide assurance and evidence of improvement in the uptake of immunisation and vaccination programmes in populations where protection is more limited, particularly in East Lincolnshire.*

# Bibliography

- Abernethy, J.K., Johnson, A.P., Guy, R., Hinton, N., Sheridan, E.A., Hope, R.J., (2015) Thirty day all-cause mortality in patients with *Escherichia coli* bacteraemia in England, *Clinical Microbiology and Infection*, 21(3), 251 e1-8
- Amirthalingam G., Andrews N., Campbell H., et al., (2014) Effectiveness of maternal pertussis vaccination in England: an observational study, *Lancet*, 384(9953), 1521-8.
- Barnett, K., Mercer, S., Norbury, M., Watt, G., Wyke, S., and Guthrie, B. (2012) Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study, *Lancet*, 380(9836), 37-43
- Bates T., (2011) MMR scare: In the wake of Wakefield, *BMJ*, 342: d806
- Bou-Antoun, S., Davies, J., Guy, R., Johnson, A.P., Sheridan, E.A., Hope, R.J., (2016) Descriptive epidemiology of *Escherichia coli* bacteraemia in England, April 2012 to March 2014, *Euro Surveill*, 21(35)
- British Heart Foundation, (2015) Physical Activity Statistics 2015, London: British Heart Foundation
- Cabinet Office, (2017) National Risk Register of Civil Emergencies available from <<https://www.gov.uk/government/publications/national-risk-register-of-civil-emergencies-2017-edition>> [Accessed Jan 2018]
- Centres for Disease Control and Prevention (2018) People at High Risk of Developing Flu-Related Complications, available from <[https://www.cdc.gov/flu/about/disease/high\\_risk.htm](https://www.cdc.gov/flu/about/disease/high_risk.htm)> [Accessed Jan 2018]
- The Chartered Society of Physiotherapy (undated) The Cost of Falls, available from <<http://www.csp.org.uk/professional-union/practice/your-business/evidence-base/cost-falls>> [accessed 24th January 2018].
- Department of Health and Social Care, (2016) Antimicrobial resistance review: government response, available from <<https://www.gov.uk/government/publications/government-response-the-review-on-antimicrobial-resistance>> [Accessed Jan 2018]
- East Midlands Clinical Senate Networks (2018) Atrial fibrillation, available from <<http://www.emsenate.nhs.uk/cardiovascular/work-programmes/atrial-fibrillation-and-heart-failure>> [accessed 13/03/18]
- European Centre for Disease Prevention and Control (ECDC)/ European Medicines Agency, (2009) EMEA Joint Technical Report: The bacterial challenge: time to react, available from <[http://www.ecdc.europa.eu/en/publications/Publications/0909\\_TER\\_The\\_Bacterial\\_Challenge\\_Time\\_to\\_React.pdf](http://www.ecdc.europa.eu/en/publications/Publications/0909_TER_The_Bacterial_Challenge_Time_to_React.pdf)> [Accessed Jan 2018]
- Eyre, D.W., Cule, M.L., Wilson, D.J., Wilson, D.J., Griffiths, D., Vaughan, A., O'Connor, L., Ip, C.L.C., Golubchick, T., Batty, E.M., Finney, J.M., Wyllie, D.H., Deidelot, X., (2013) Diverse sources of *C. difficile* infection identified on whole-genome sequencing, *New England Journal of Medicine*, 369(13), 1195-205
- Food Standards Agency, (2011) Foodborne disease strategy 2010-15, available from <<https://www.food.gov.uk/sites/default/files/multimedia/pdfs/fds2015.pdf>> [Accessed Jan 2018]
- Gale, C., Westbury, L., and Cooper, C. (2018) Social Isolation and Loneliness as risk factors for the progression of frailty: the English Longitudinal Study of Ageing. *Gerontology*, 64(1), 58-66
- Gallagher N., Johnston J., Crookshanks H., Nugent C., and Irvine N., (2017) Characteristics of respiratory outbreaks in care homes during four influenza seasons, 2011-2015, *Journal of Hospital Infection*, S0195-6701 (17), 30464-4
- Gee, E. M., and Gutman, G. M. (2000) Introduction, In E. M. Gee & G. M. Gutman (editors), *The overselling of population aging: apocalyptic demography, intergenerational challenges, and social policy*, Oxford: Oxford University Press
- Holgate S. and Stokes-Lampard H., (2017) Air pollution -a wicked problem, *BMJ*, 357: j2814
- HPZone, (2016) Home, available from <<http://hpzoneinfo.in-fact.com/>> [Accessed March 2018]
- Keenan, T.A., (2010) Home and community preferences of the 45+ population, Washington: AARP.
- Kingston, A., Robinson, L., Booth, H., Knapp, M., and Jagger, C. (2018) Projections of multi-morbidity in the older population in England to 2035: estimates from the Population Ageing and Care Simulation (PACSim) model, *Age and Ageing*, Epub ahead of print, available from <<https://academic.oup.com/ageing/advance-article/doi/10.1093/ageing/afx201/4815738>>
- Marengoni, A., Angleman, S., and Melis, R., (2011) Ageing with multi-morbidity: a systematic review of the literature, *Ageing Research Review*, 10(4), 430-9
- Moss WJ., (2017) Measles, *Lancet*; 390(10111), 2490-502
- Munro, A., Kovats, R.S., Rubin, G.J., Waite, T.D., Bone, A., Armstrong, (2017) Effect of evacuation and displacement on the association between flooding and

- mental health outcomes: a cross-sectional analysis of UK survey data, *Lancet Planet Health* 1(4), e134-e41
- National Institute for Health and Care Excellence, (2016) Multimorbidity: clinical assessment and management, NICE guideline (NG56) available from <<https://www.nice.org.uk/guidance/ng56>> [accessed 14/03/18]
- National Institute for Health and Care Excellence, (2017) Clinical Knowledge Summary, Stroke and TIA, available from <<https://cks.nice.org.uk/stroke-and-tia>> [accessed 13th March 2018]
- National Travel Health Network and Centre, available from <<https://nathnac.net/>> [Accessed Jan 2018]
- NHS England, (2018) Stroke Pathway, available from <<https://www.england.nhs.uk/rightcare/products/pathways/stroke-pathway/>> [accessed 13/03/18]
- Office of National Statistics, (2017) Population Projections, London: ONS
- O'Neill J., (2014) Review on Antimicrobial Resistance Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations. Review on Antimicrobial Resistance, available from <[https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations\\_1.pdf](https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf)> [Accessed Jan 2018]
- Pannell, J., Aldridge, H. and Kenway, P., (2012) Older people's housing: choice, quality of life, and under-occupation, York: Joseph Rowntree Foundation
- Patient UK, (2018) UK Immunisation Schedule, available from <<https://patient.info/doctor/immunisation-schedule-uk>> [Accessed March 2018]
- Projecting Older People Population Information, (2017) Oxford: Oxford Brookes University available from <<http://www.poppi.org.uk/>> [Accessed March 2018]
- Public Health England, (2015) The burden of disease and what it means in England, available from <<https://publichealthmatters.blog.gov.uk/2015/09/15/the-burden-of-disease-and-what-it-means-in-england/>> [Accessed March 2018] a
- Public Health England, (2016) Cardiovascular disease: getting serious about prevention, available from <<https://www.gov.uk/government/publications/cardiovascular-disease-getting-serious-about-prevention>> [Accessed 14/03/18] b
- Public Health England, (2017) Complete routine immunisation schedule, available from <<https://www.gov.uk/government/publications/the-complete-routine-immunisation-schedule>> [Accessed Jan 2018] b
- Public Health England, (2015) Ebola virus disease: clinical management and guidance available from <<https://www.gov.uk/government/collections/ebola-virus-disease-clinical-management-and-guidance>> [Accessed Jan 2018]
- Public Health England, (2017) Falls and fracture consensus statement: Supporting commissioning for prevention, London: Public Health England, a
- Public Health England, (2017) Meningococcal disease: guidance, data and analysis. Available from <<https://www.gov.uk/government/collections/meningococcal-disease-guidance-data-and-analysis>> [Accessed Jan 2018] c
- Public Health England, (2010), Notifiable disease and causative organisms: how to report, available from <<https://www.gov.uk/guidance/notifiable-diseases-and-causative-organisms-how-to-report>> [Accessed Jan 2018]
- Public Health England (undated) Public Health Outcomes Framework, available from <<https://fingertips.phe.org.uk/profile/public-health-outcomes-framework>> [accessed 24th January 2018], b
- Public Health England, (2017) Tuberculosis in England - 2017 report, available from <[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/654152/TB\\_Annual\\_Report\\_2017.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/654152/TB_Annual_Report_2017.pdf)> [Accessed Jan 2018] d
- Public Health England, (2017) Zika virus (ZIKV): clinical and travel guidance, available from <<https://www.gov.uk/government/collections/zika-virus-zikv-clinical-and-travel-guidance>> [Accessed Jan 2018] e
- Robertson, A. (1997) Beyond apocalyptic demography: towards a moral economy of interdependence, *Ageing and Society*, 17, 425–446
- Sacks, J.D., Stanek, L.W., Luben T.J., Johns, D.O., Buckley, B.J., Brown, J.S., Ross, M., (2011) Particulate matter-induced health effects: who is susceptible? *Environmental Health Perspectives*, 119(4), 446-54
- Salive, M., (2013) Multimorbidity in older adults, *Epidemiology Review*, 35(1), 75-83
- Semenza JC, Suk JE, Tsovala S., (2010), Social determinants of infectious diseases: a public health priority, *Euro Surveill*, 15(27), 2-4
- Sommer I., Griebler U., Mahlknecht P., et al., (2015), Socioeconomic inequalities in non-communicable diseases and their risk factors: an overview of systematic reviews, *BMC Public Health*, 15: 914
- Stroke Association, (2018) Atrial fibrillation, available from <<https://www.stroke.org.uk/what-is-stroke/are-you-at-risk-of-stroke/atrial-fibrillation>> [Accessed 13/03/18] a

Stroke Association, (2018) Understand stroke, available from <<http://www.stroke.org/understand-stroke/what-stroke>> [Accessed 13/03/18] b

Van Dijk, H.M., Cramm, J.M., Van Exel, J.O.B. and Nieboer, A.P. (2014) The ideal neighbourhood for ageing in place as perceived by frail and non-frail community-dwelling older people, *Ageing and Society*, 35(8), 1771-95

Ventola, CL., (2015) The antibiotic resistance crisis: part 1: causes and threats. *P T*, 40(4): 277-83

Victor, C.R. and Bowling, A., (2012) A longitudinal analysis of loneliness among older people in Great Britain, *Journal of Psychology*, 146(3), 313-331

Victor, C.R., Scambler, S.J., Bowling, A.N.N., and Bond, J., (2005) The prevalence of, and risk factors for, loneliness in later life: a survey of older people in Great Britain, *Ageing and Society*, 25(6), 357-75

Wiles, J.L., Leibing, A., Guberman, N., Reeve, J. and Allen, R.E.S., (2012) The meaning of 'Ageing in Place' to older people, *Gerontologist*, 52(2), 357-66

World Health Organisation, (2010) Environment and health risks: a review of the influence and effects of social inequalities, available from <[http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0003/78069/E93670.pdf](http://www.euro.who.int/__data/assets/pdf_file/0003/78069/E93670.pdf)> [Accessed Jan 2018]