Tick bites and Lyme disease:
History and best practice for reducing risk of infection

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Ticks: You and Your Livelihood Workshop
Lonach Hall, Strathdon
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Outline

- History of Lyme disease
- Epidemiology
- Lyme disease
  - Signs and symptoms
  - Testing and diagnosis
  - Treatment and complications
- Prevention
  - Avoidance
  - Tick removal
- Risk Management and minimisation

Ixodes ricinus – the vector of disease

History

- 1974-5, Old Lyme, Connecticut, USA
- Unusual cluster of cases of juvenile rheumatoid arthritis in young people
- Several cases of tick-borne infections recorded from early 1900s
- *Borrelia burgdorferi* identified 1983
- Gram-negative, spiral bacteria, class known as Spirochetes

Borrelia burgdorferi, Image: 1983 PHIL/CDC

- Disease now recognised in focal regions of the US and Canada, Europe and central Asia
- > 100,000 new cases diagnosed and treated each year world-wide
- > 1,200 confirmed reports each year in the UK; rising trend

Distribution of ticks and spirochetes

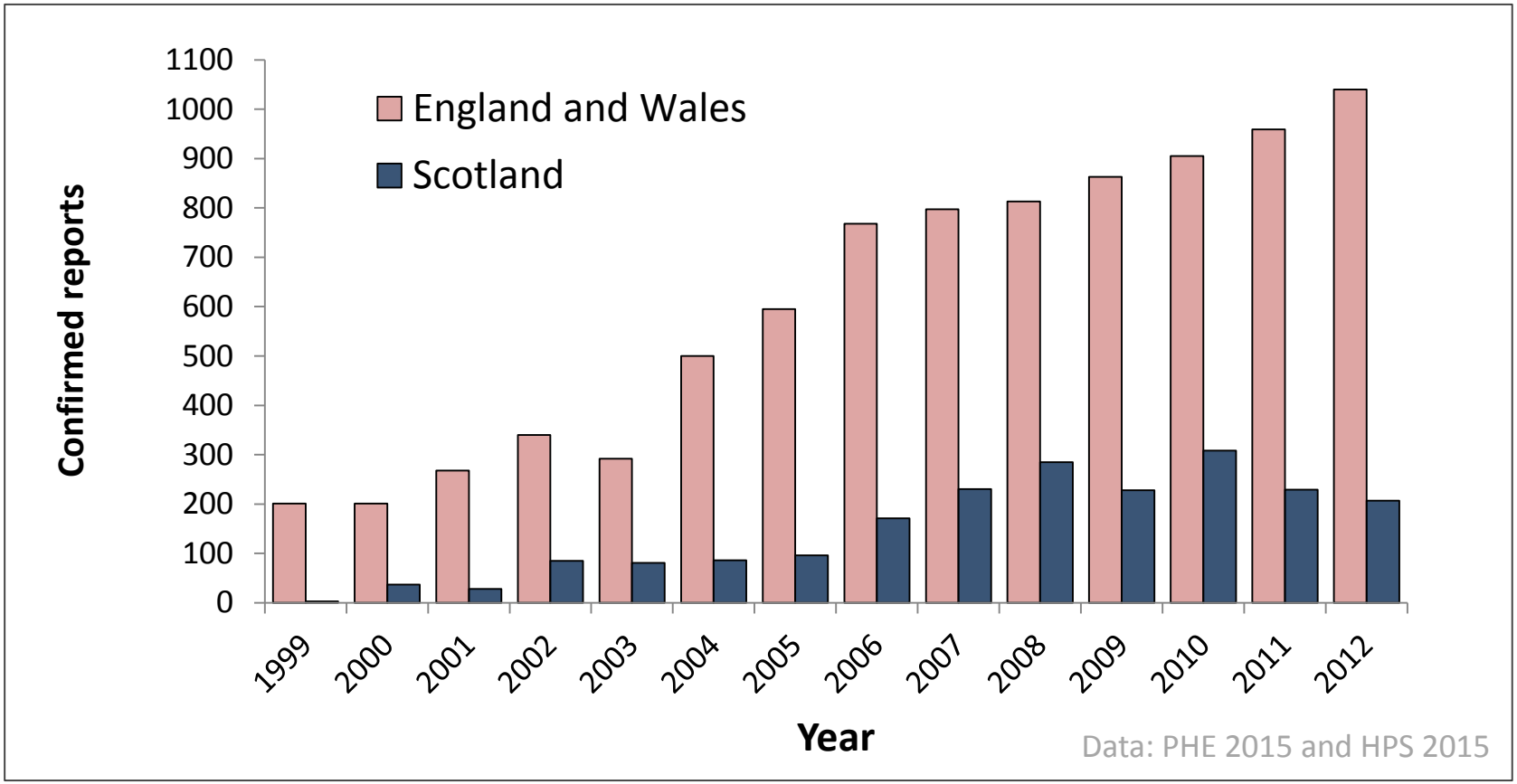
Table 1. Geographic distribution of the most important *Ixodes* ticks and associated spirochete bacteria in Lyme disease (Steere 2001, Steere *et al* 2004).

Region/foci	*Ixodes* species (vector)	Spirochete bacteria (agent)
North America		
New England and Midwest	*Ixodes scapularis*[1]	*Borrelia burgdorferi*
Northern Calif/Oregon	*Ixodes pacificus*	*Borrelia borgdorferi*
Europe and Scandinavia	*Ixodes ricinus*	*Borrelia afzelii* *Borrelia garinii* *Borrelia burgdorferi*
Asia	*Ixodes persulcatus*	*Borrelia afzelii* *Borrelia garinii*

[1] synonym - *Ixodes dammini*

Source: Wilson and Smith 2009

Epidemiology of Lyme disease in the UK 1999-2012



- Occupationally-acquired infections are reported to the Health and Safety Executive
- Confirmed reports are thought to significantly underestimate true incidence
- Up to 20 percent of cases in any year are acquired abroad

Lyme disease: Factors and Trends

- Factors thought to be responsible for the rising trend in the number of infections:
  - Improved diagnostics
  - Increased awareness and reporting of infection
  - Improved habitat for host species
  - Successive mild winters enabling ticks to survive
  - Growth in recreational travel to high-risk areas (UK and overseas)

Policy Drivers in Health: Physical activity and health

Be Active, Be Healthy. Department of Health 2009.
The Scottish Health Survey. Scottish Government 2009.

Childhood experience in woods and nature is important in determining exercise preferences in later life


Psychological benefits of trees, woods, nature
Day-Surgery Recovery Room (2011), Sheffield

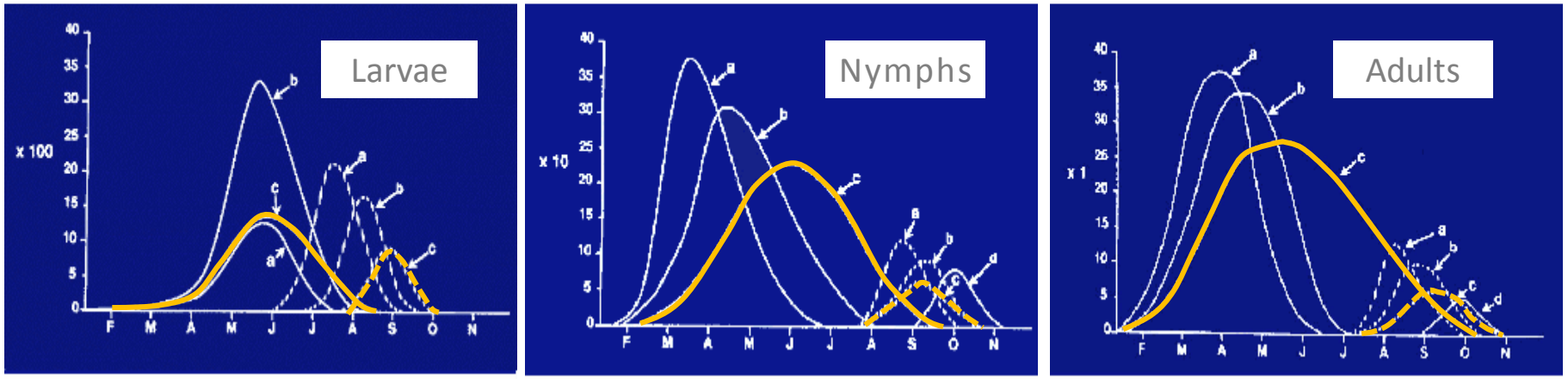
Epidemiology of Lyme disease in the UK

- Who is at risk of acquiring Lyme disease?
  - **Occupational**: Forestry workers, deer managers, gamekeepers, farmers, soldiers, outdoor educators, conservationists
  - **Recreational**: ramblers, campers, ornithologists, nature photographers, returning travellers (from focal regions in US and EU)
- Where are "hotspots" in the UK?
  - New Forest, Thetford Forest, South Downs, Exmoor, woodland/heathland in southern England, North York Moors, Lake District, Scottish Highlands
  - **Other local areas** $\rightarrow f(\text{habitat} \times \text{host species} \times \text{humans})$

Urban green space and gardens can be effective tick habitats

- Parks and gardens provide excellent habitat for squirrels, hedgehogs, rodents, birds
- Herbaceous vegetation especially interesting for children at play, pet dogs

Ixodid ticks can be active for most of the year in woodland habitats



Seasonal activity of *Ixodes ricinus* in different habitats

a = exposed meadow
b = dense hill vegetation or secondary deciduous woodland
c = highly sheltered woodland (——)
d = spring-derived but autumn-feeding

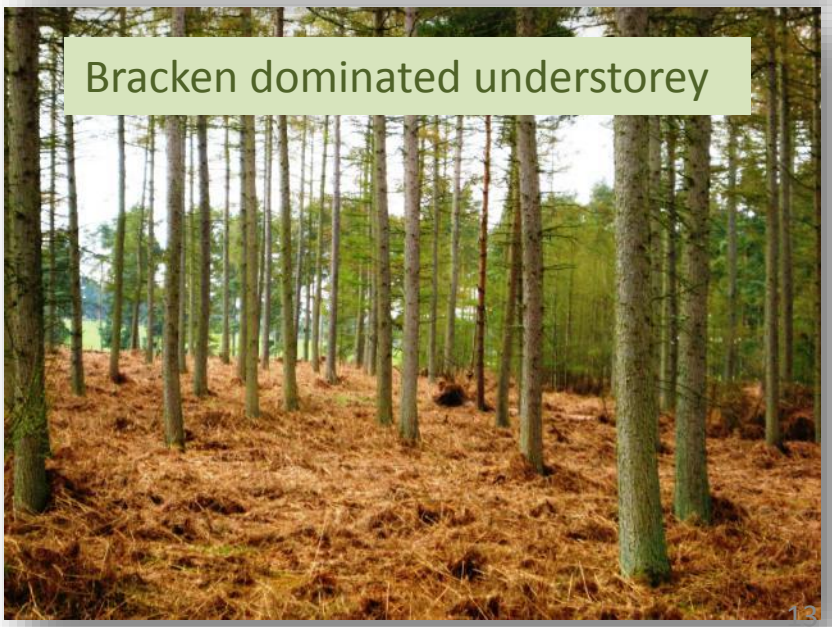
Solid line = spring population
Broken line = autumn population

Source: Prof. J. Gray/EUCALB 2010

Tick habitat

Image: BADA-UK

Tick “questing”



Ixodid tick morphology and development

Identification Tip! Ticks are arthropods (related to spiders and mites). Nymph/adult ticks have **4 pairs of legs.** (Remember insects have only 3 pairs of legs.)

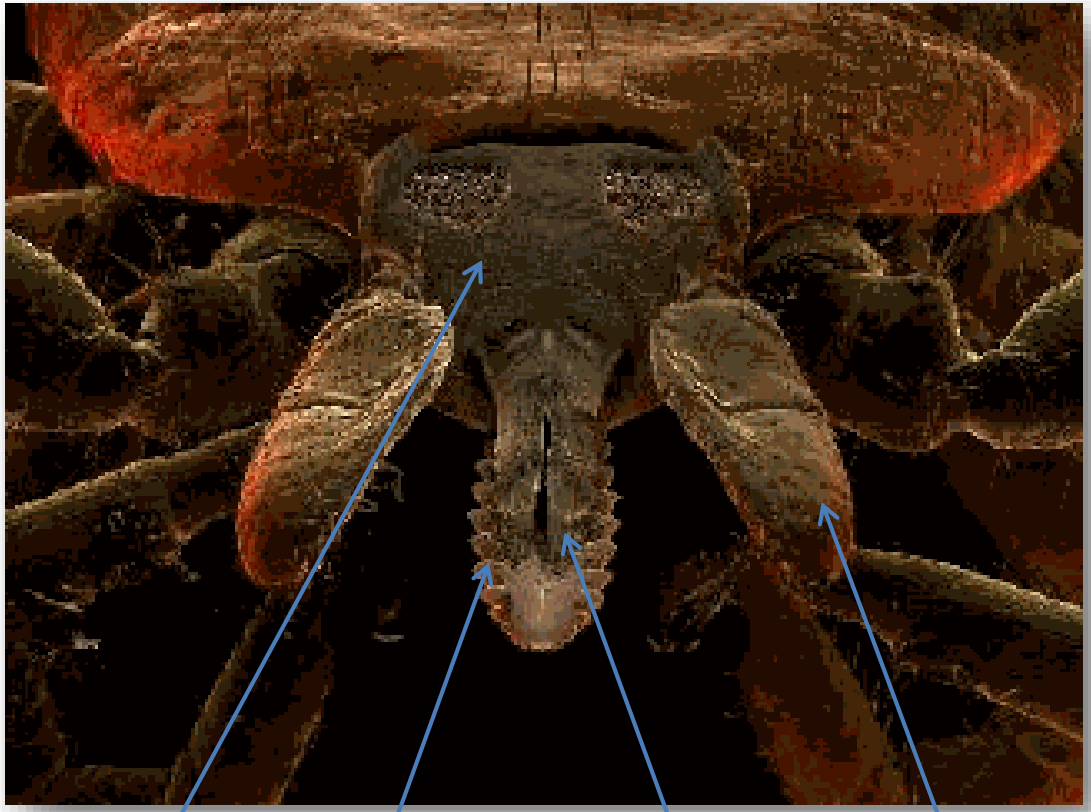
Nymph

- 1 to 1.5 mm in size
- difficult to detect

Adult (female)

- 3 to 3.5 mm in size
- males are smaller
- can remain attached to host for several days

Ixodid tick head and mouthparts



Images: D. Scharf/Brown Univ. USA

Start and completion of a blood feed

Image: LDA

- **It usually takes many hours before a tick transfers the *Borrelia* bacteria to the host**
- Ticks are skilled at evading early detection - bites are painless
- They naturally focus on moist, warm areas of the body, often in skin folds
- Undisturbed, feeding will continue for several days
- A fully engorged tick will measure up to 10 mm in size, and appear like a small bean

Ixodid tick feeding

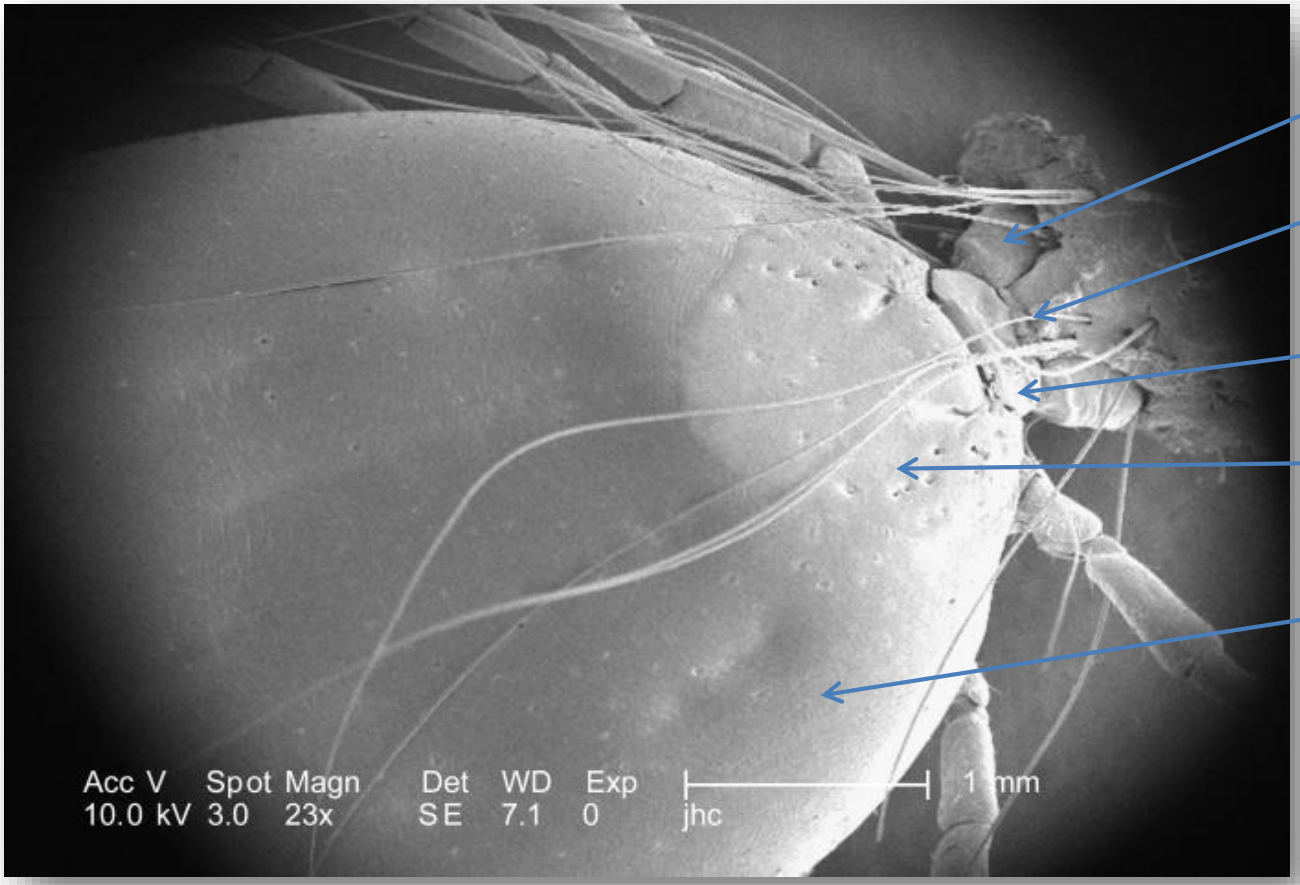
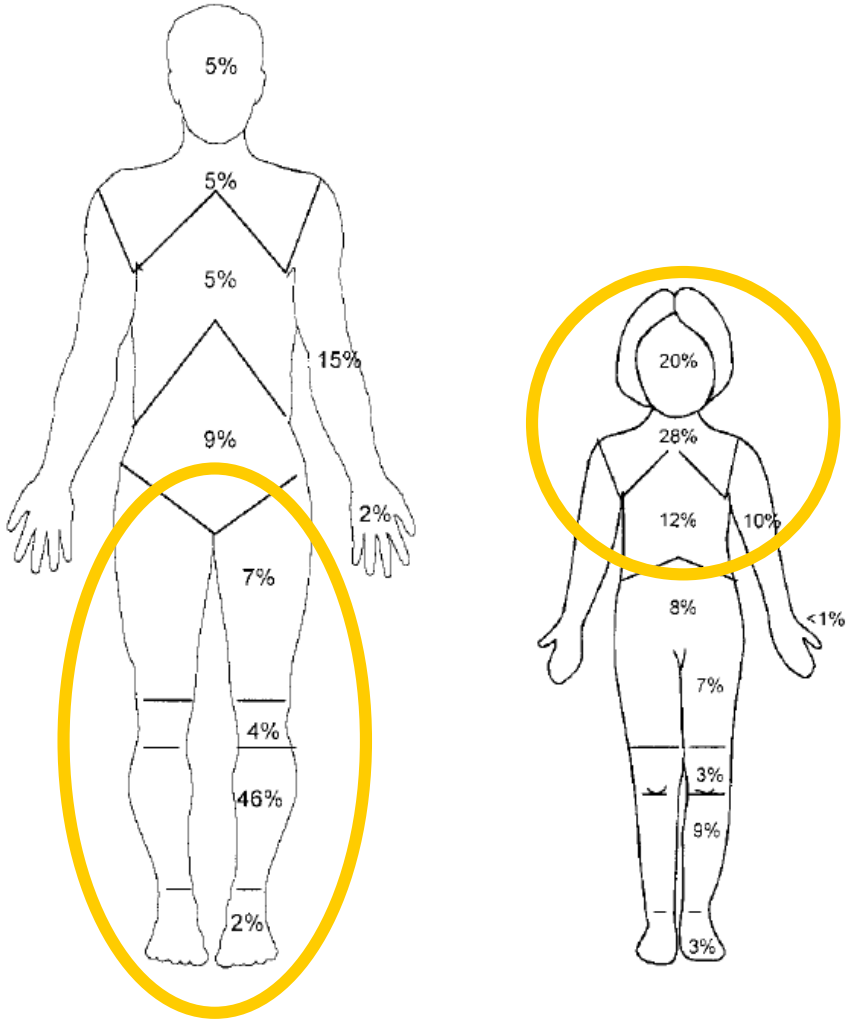


Image: 2006 Janice Carr PHIL/CDC

- Low magnification (23×) scanning electron micrograph (SEM)
- Dorsal view of engorged female tick, extracted from a pet cat

Anatomical distribution of nymphal tick bites

% of total nymphal bites, recreational forest site, England



Adults mainly bitten below waist

Children mainly bitten above waist

Source: Robertson et al. 2000. Eur J Epidem 16: 647-652

Removal of ticks

Best practice

- **Don’t panic**
- Aim to remove the tick promptly
- Grip the tick by its mouthparts
- Use a dedicated **tick tool**, follow instructions
- Use **fine tweezers** – pull firmly, steadily, no twisting
- Disinfect site of bite after removing the tick

Image: BADA-UK

Image: LDA

Unsafe practice

- **Don’t squeeze** the body of the tick
- **Don’t twist** (unless using a tick tool)
- **Don’t use fingernails**
- **Don’t burn** the tick
- **Don’t use** oils, alcohol, nail varnish

Retain ticks - Tick Recoding Scheme – Public Health England

Symptoms and signs

Early:

- red, expanding target rash
- feeling unwell or 'flu-like'
- headache, stiff neck
- swollen lymph nodes
- sound or light sensitivity

Acute:

- facial palsy
- heart problems
- breathing problems

Weeks, months, years:

- arthritis, typically of the knee
- sleep disorders
- extreme fatigue
- upset digestive system
- loss of weight
- muscle pain and/or weakness
- tendon pain
- tingling and numbness
- cognitive and psychological problems

Erythema migrans (EM) – the target rash

Important clinical feature – but not always present

Image: LDA

Image: LDA

Image: LDA

- The rash expands from the site of the bite and gradually clears in the centre
- The rash appears over 3-30 days and may persist for several weeks
- The rash does not appear in over 40% of cases in Scotland
- The rash can be a wide variety of shapes depending on the location of the bite

Diagnosis

Clinical

1. Exposure to ticks
2. EM rash
3. Matching symptoms

Laboratory

- Two stage test specific to Lyme disease
- **ELISA** test, confirmed if positive by **Western Blot**

- Initial treatment based on clinical diagnosis (i.e., signs and symptoms)
- Testing is only effective several weeks after initial infection
  - infection in disseminated phase
- *Negative results (either first or second-tier) should not be used to exclude Lyme disease*

Source: Public Health England, Health Protection Scotland

Treatment

- **Early treatment is more likely to be successful**
- **Treatment is with antibiotics**
  - Advise your doctor if you have a known drug allergy
- Following **early diagnosis** of Lyme disease:
  - Typically, 2-4 weeks e.g. Doxycycline
  - Usually complete recovery
- Following **late diagnosis** of Lyme disease:
  - Specialist care may be required
  - Some symptoms may persist
- **Post-Treatment Lyme Disease**
  - Prolonged ill-health in some patients (not well understood at present)

Treatment Advice

NHS Choices

- If you develop symptoms of Lyme disease, you will normally be given a course of antibiotic tablets, capsules or liquid. Most people will require a two- to four-week course, depending on the stage of the condition.
- If you are prescribed antibiotics, it's important you finish the course even if you are feeling better, because this will help ensure all the bacteria are killed.
- If your symptoms are particularly severe, you may be referred to a specialist to have antibiotic injections (intravenous antibiotics).
- Some of the antibiotics used to treat Lyme disease can make your skin more sensitive to sunlight. In these cases, you should avoid prolonged exposure to the sun and not use sunbeds until after you have finished the treatment.
- There's currently no clear consensus on the best treatment for post-infectious Lyme disease because the underlying cause is not yet clear.
- Be wary of internet sites offering alternative diagnostic tests and treatments that may not be supported by scientific evidence.

http://www.nhs.uk/conditions/Lyme-disease

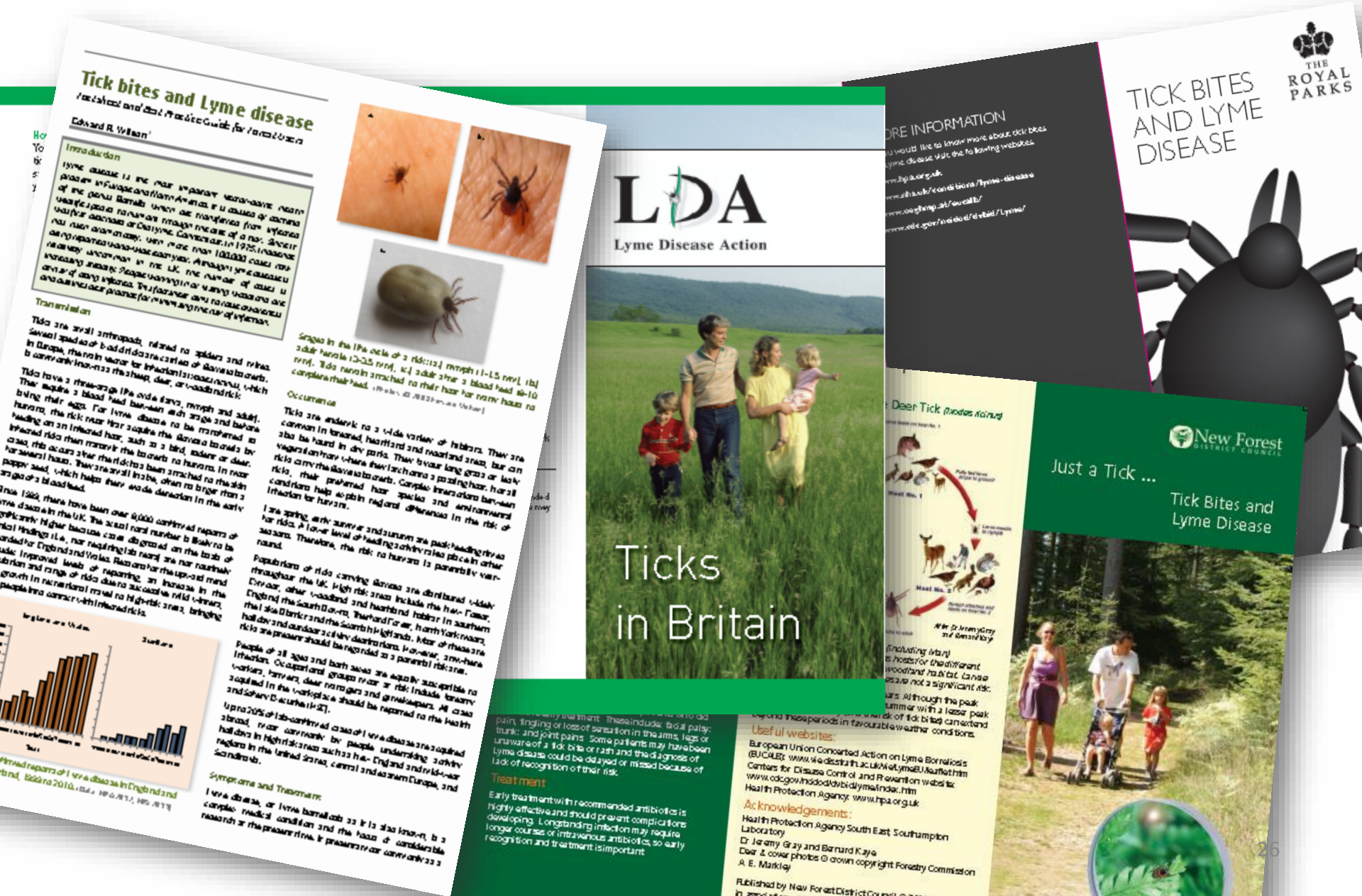
Accessed 18 Nov 2015

Prevention

Almost like an amendment to Countryside Code

- **Wear appropriate clothing** - long sleeved shirt and long trousers tucked into socks
- **Light coloured fabrics** are useful, as it is easier to see ticks against a light background
- Consider using an **insect repellent/acaricide** containing N,N-diethyl-m-toluamide (DEET)
- **Inspect skin frequently** and safely remove any attached ticks as soon as possible after noticing them
- **Keep to paths** and avoid long grass or overgrown vegetation, as ticks crawl up long grass in their search for a feed (questing)
- **At the end of the day, check again for ticks**, especially in skin folds
- **Check children**, especially head and neck areas, including scalps. Remember only to check children if you are qualified/authorised; otherwise advise parents to check their own children.
- **Check clothing and equipment**
- **Check pets**

Accessible public health information is key



Prevention and Risk Reduction

- **Risk** – *"the probability of a particular adverse event occurring in a stated period of time"*
  - Probability
  - Consequence
- Risks in woodlands include: activity undertaken, management +/-, animals/stock, climate, biological conditions.
- Communicating risks?
  - Recent papers – e.g., O'Brien et al 2012; Marcu et al 2013

A high risk area: forest clearing with broadleaf regeneration and a large mat of bracken

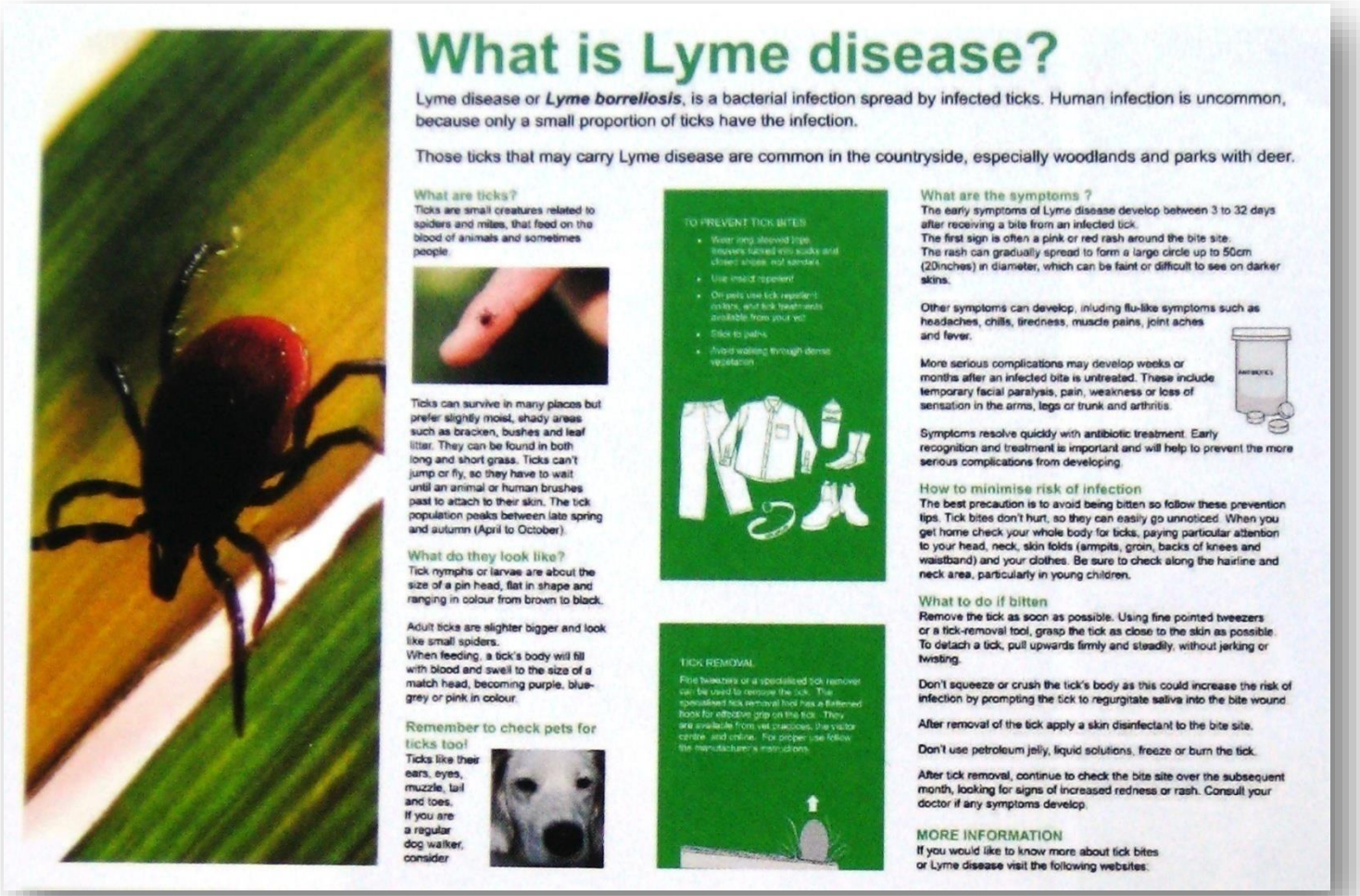
Making use of vegetation dynamics – maintain moderate shade in high access areas

Public Engagement Research:
Understanding risk during a woodland visit in SE England
(O'Brien et al 2012)

- **Objectives:**
  1. what sort of risk people expect to encounter and their response
  2. Awareness of Lyme disease, response to information and actions they might take
  3. How these influence people's values of woodland
- **Methods:**
  1. Photo elicitation task
  2. Semi-structured group discussion
  3. Evaluation of two posters, perception of risk, preferences for information

Source: Scottish Forestry 66(4): 14-24 (2012)

Example Lyme Disease Poster
Royal Parks, London



What is Lyme disease?

Lyme disease or ***Lyme borreliosis***, is a bacterial infection spread by infected ticks. Human infection is uncommon, because only a small proportion of ticks have the infection.

Those ticks that may carry Lyme disease are common in the countryside, especially woodlands and parks with deer.

What are ticks?

Ticks are small creatures related to spiders and mites, that feed on the blood of animals and sometimes people.

Ticks can survive in many places but prefer slightly moist, shady areas such as bracken, bushes and leaf litter. They can be found in both long and short grass. Ticks can't jump or fly, so they have to wait until an animal or human brushes past to attach to their skin. The tick population peaks between late spring and autumn (April to October).

What do they look like?

Tick nymphs or larvae are about the size of a pin head, flat in shape and ranging in colour from brown to black.

Adult ticks are slighter bigger and look like small spiders.
When feeding, a tick's body will fill with blood and swell to the size of a match head, becoming purple, blue-grey or pink in colour.

Remember to check pets for ticks too!

Ticks like their ears, eyes, muzzle, tail and toes.
If you are a regular dog walker, consider

TO PREVENT TICK BITES

- Wear long sleeved tops, trousers tucked into socks and closed shoes, not sandals.
- Use insect repellent
- On pets use tick repellent collars, and tick treatments available from your vet
- Stick to paths
- Avoid walking through dense vegetation

TICK REMOVAL

Fine tweezers or a specialised tick remover can be used to remove the tick. The specialised tick removal tool has a flattened hook for effective grip on the tick. They are available from vet practices, the visitor centre, and online. For proper use follow the manufacturer's instructions.

What are the symptoms ?

The early symptoms of Lyme disease develop between 3 to 32 days after receiving a bite from an infected tick.
The first sign is often a pink or red rash around the bite site.
The rash can gradually spread to form a large circle up to 50cm (20inches) in diameter, which can be faint or difficult to see on darker skins.

Other symptoms can develop, inluding flu-like symptoms such as headaches, chills, tiredness, muscle pains, joint aches and fever.

More serious complications may develop weeks or months after an infected bite is untreated. These include temporary facial paralysis, pain, weakness or loss of sensation in the arms, legs or trunk and arthritis.

Symptoms resolve quickly with antibiotic treatment. Early recognition and treatment is important and will help to prevent the more serious complications from developing.

How to minimise risk of infection

The best precaution is to avoid being bitten so follow these prevention tips. Tick bites don't hurt, so they can easily go unnoticed. When you get home check your whole body for ticks, paying particular attention to your head, neck, skin folds (armpits, groin, backs of knees and waistband) and your clothes. Be sure to check along the hairline and neck area, particularly in young children.

What to do if bitten

Remove the tick as soon as possible. Using fine pointed tweezers or a tick-removal tool, grasp the tick as close to the skin as possible. To detach a tick, pull upwards firmly and steadily, without jerking or twisting.

Don't squeeze or crush the tick's body as this could increase the risk of infection by prompting the tick to regurgitate saliva into the bite wound.

After removal of the tick apply a skin disinfectant to the bite site.

Don't use petroleum jelly, liquid solutions, freeze or burn the tick.

After tick removal, continue to check the bite site over the subsequent month, looking for signs of increased redness or rash. Consult your doctor if any symptoms develop.

MORE INFORMATION

If you would like to know more about tick bites or Lyme disease visit the following websites:

Public Engagement Research:
Understanding risk during a woodland visit in SE England
(O'Brien et al 2012)

- **Results: Taking action or not?**
  - **Preference for taking action after a visit**
    - Checking skin for bites, rash
    - Visiting doctor in event of symptoms
  - **Precautionary actions**
    - Covering bare skin, insect repellent
    - Viewed as impinging on participants' normal practice (esp. In younger age group) and reduced value of experience
  - **Relative risk?**
    - Issues with signage – too many signs about "health and safety" reduce visitor experience , lower perception of naturalness

Public Engagement Research:
Understanding risk during a woodland visit in SE England
(O'Brien et al 2012)

- **Outcomes**
  - Many personal benefits from contact with nature
    - Physical exercise, Psychological restoration, Social contact
  - Focusing too much on risk can detract from the experience
    - *"distancing from risk"* (Marcu et al 2011)
  - Advice at odds with behaviour preference was unlikely to be adopted

Public Engagement Research:
Understanding risk during a woodland visit in SE England
(O'Brien et al 2012)

- **Managing woodland visits:**
  - Providing information that does not seem to impede or reduce recreational use of woodlands
  - Short, clear, concise warning messages most appropriate and effective
  - **Focus on post-visit action** (see also Marcu et al 2013)
  - *"Naturalness of setting"* is important, sensitive placement of signs is essential
  - Responsible management does not equate with a lot of visible warnings

Case Studies: Positive Action in Practice

- **Case Study 1**: **Forestry Commission**
  - Staff induction and Health and Safety
  - Information (intranet) and training, tick tools
  - Risk assessments
- **Case Study 2: National Outdoor Centre, Glenmore Lodge, Cairngorms**
  - Staff induction
  - Awareness and training, tick tools
  - Testing (ELISA)
- **Case Study 3: Whinfell Forest, Center Parcs Holiday Village, Penrith, Cumbria**
  - Education and awareness - ground staff and visitors
  - Medical Centre – trained staff and information leaflets
  - Bracken control/habitat modification (esp. By footpaths)

Awareness raising at Whinfell Forest Village, Cumbria (Center Parcs)

Risk assessment and appropriate clothing required to access more natural woodland areas

Woodland paths with moderate risk: dense ground vegetation and overhanging saplings

Lower risk habitat with paths carefully prepared and vegetation cut back

Health Information for Outdoor Users: Key Points

1. **Enjoy the outdoors for work and pleasure**
   - it's great for physical and emotional well-being!
2. **Before going outdoors**
   - be aware of ticks and tick ecology
3. **While outdoors**
   - minimise risk of being bitten: dress appropriately; apply acaricide; avoid dense vegetation (questing)
4. **After being outdoors**
   - check for ticks on skin and clothes; check children; check the dog too!
5. **If bitten by a tick**
   - remove promptly using a **safe technique**
6. **Medical treatment**
   - seek early diagnosis and treatment if symptoms of infection develop after being bitten or after visiting tick habitat
   - early diagnosis is easier to treat with ABx
7. **If in any doubt, speak with your GP**

Images: Forestry Commission

Take Home Points 1

1. The potential **risk of Lyme disease is increasing** for many social, environmental and ecological reasons.

2. The risk of being bitten by an infected tick is **modifiable** through application of **ecological knowledge**, often at the local scale, and also an understanding of **how we interact with natural environments**.

3. **Inform, not scare**. Public Health Information needs to be **targeted**, **normalised** and **empowering** so that more people can safely engage with the natural environment for their physical and emotional well-being.

Take Home Points 2

4. **Be aware and protect yourself** from tick bites

5. **Remove attached ticks promptly**, using a safe technique. Ticks needs to be attached for many hours to transmit infection, if present in the tick. Retain tick, if possible, and send to the PHE Tick Recording Scheme.

6. **Seek early diagnosis and treatment** if you have been exposed to ticks **and** later present with symptoms of infection.

- **If in doubt, always seek advice from your GP**

Resources and Website Links

UK Agencies

- **NHS Choices** – Lyme Disease - www.nhs.uk/conditions/Lyme-disease
- **Health Protection Scotland** (HPS) - www.hps.scot.nhs.uk/giz/lymedisease.aspx
- **Public Health England** (PHE) - www.gov.uk/government/collections/lyme-disease-guidance-data-and-analysis
- **Tick Recording Scheme** - www.rfs.org.uk/news/hot-topics/lyme-disease/

International Agencies

- **European Concerted Action on Lyme Borreliosis** (EUCALB) - http://meduni09.edis.at/eucalb
- **US Centers for Disease Control and Prevention** (CDC) - www.cdc.gov/lyme/index.html

UK Charities

- **Lyme Disease Action** (LDA) - www.lymediseaseaction.org.uk
- **Royal Forestry Society** - www.rfs.org.uk/news/hot-topics/lyme-disease/

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