**Prophylaxis of infection Guidelines**

**Introduction**

This guideline has been developed to help prevent future infections in patients who are more at risk of developing infections. This may be through either having recurrent infections, having received courses of antibiotic treatments, or having one significant infection or hospital admission. As there may be many contributing factors to developing infections, it is important to consider a holistic approach to our health and wellbeing using the 6 pillars of lifestyle medicine to optimise our health.

**An introduction to your gut microbiome**

This guideline will introduce you to the importance of your gut microbiome in preventing and fighting infections. The science of the gut microbiome is very new so please read this section to learn more.

We all share our human bodies with trillions of bacteria, viruses, fungi and other living organisms (microbes). It turns out that they have set up home almost everywhere in our bodies; even in our organs, blood and brain. The largest collection of these microorganisms is in the **Gut Microbiome** which is the collection of microorganisms in the whole digestive tract, from the mouth to the anus. Within the gut microbiome there are areas with a greater number and variety of microbes, such as the mouth and the large bowel. There are also areas with much fewer microbes and less species, such as the stomach and small bowel.

There are many other **Microbiomes** in the body, for example the skin and lung microbiomes. For the purpose of this guideline we will focus on just the gut microbiome.

So why we should be interested in this ecosystem of microbes? It turns out that they are not simply catching a ride but are actively participating in many different aspects of our health. Without these microbes our immune system would collapse and we would die of infections as soon as we encounter them. They also play an important role in our digestive health, our sugar and fat metabolism, and they help us to create essential hormones, vitamins and chemical messengers. In short, these microorganisms are essential for our day-to-day bodily functions and disease prevention.

There is however a problem with our gut microbiome, which is that modern living can significantly damage it. A western diet high in processed foods, fat and sugar will encourage more harmful microbes to take up residence in our gut microbiome. On the other hand, if we eat a diet rich in fibre and whole plants we will feed the microbes that we want to dominate our gut microbiome. As you will read, other aspects of our lifestyle can also harm our gut microbiome too.

A damaged microbiome can struggle to protect us from infection and disease and it has also been implicated in most chronic diseases such as heart disease, diabetes, dementia and cancer. This guideline seeks to address the important role our gut microbiome plays in our immune function and consider ways in which we can enhance this brilliant ecosystem to help us tackle infections and recover well from them.

**Antibiotics and our gut microbiome**

Antibiotics are an essential tool in the treatment of infectious diseases and they have played a vital role in improving our health and longevity. Despite their benefits, antibiotics can also be harmful to us too. This guideline recognises the negative impact antibiotics can have on our gut microbiomes. Antibiotics vary in their impact on the gut microbiome with some only affecting a small number of species (narrow spectrum antibiotics) whilst more broad spectrum antibiotics can have a damaging effect on a larger number of species. Antibiotics also vary in their strength and some people only require a very short course of antibiotics whilst for more serious infections we sometimes use more prolonged courses. As such, the impact on the gut microbiome and recovery time can vary between people. The impact can also differ because the health of the gut microbiome before treatment can vary. These guidelines seek to offer ways that we can help our gut microbiome recover more quickly following antibiotics and illness. Good recovery will enable the immune system to help us prevent future infection and disease.

**Who is this guideline for?**

1. **Anybody who has received antibiotics recently** – Antibiotic damage of the resident microbial communities in the gut microbiota can take over a year to recover, depending on the host’s diet and lifestyle. Antibiotics can affect the metabolic function and immune function of the gut microbiome as well as impacting on its diversity and composition. These changes can increase the risk of further infections.
2. **Anybody who has had a recent infection** – Developing an infection may be a sign that your immune defence is not as good as it could be, and optimising your lifestyle can reduce your risk of future infections. Recurrent infections may be an indication of an unhealthy (dysbiotic) gut microbiome2,3. In addition, infections and the medicines we use to treat them – Eg antibiotics, antivirals, antifungals - can cause perturbations in the gut microbiome which can affect our immune system within the gut and beyond.
3. **Anybody who has had a stay in hospital** – Being admitted to hospital can be lifesaving and provide essential medical or surgical treatments. However, staying in hospital can affect your gut microbiome through many different mechanisms – loss of sleep, stress, change in diet, lack of exercise as well as the drugs you are exposed to. In addition, you are more likely to develop hospital acquired infections after even a short stay in a hospital environment.

Ref

1. Recovery of the Gut Microbiota after Antibiotics Depends on Host Diet, Community Context, and Environmental Reservoirs. (2019). Cell Host & Microbe. <https://doi.org/10.1016/j.chom.2019.10.011>
2. Worby, C. J., Schreiber, th, Straub, T. J., van Dijk, L. R., Bronson, R. A., Olson, B. S., Pinkner, J. S., Obernuefemann, C. L. P., Muñoz, V. L., Paharik, A. E., Azimzadeh, P. N., Walker, B. J., Desjardins, C. A., Chou, W.-C., Bergeron, K., Chapman, S. B., Klim, A., Manson, A. L., Hannan, T. J., … Earl, A. M. (2022). Longitudinal multi-omics analyses link gut microbiome dysbiosis with recurrent urinary tract infections in women. *Nature Microbiology*, *7*(5), 630–639. <https://doi.org/10.1038/s41564-022-01107-x>
3. Anna Maria Seekatz, Nasia Safdar, & Sahil Khanna. (2022). The role of the gut microbiome in colonization resistance and recurrent infection. *Therapeutic Advances in Gastroenterology*, *15*. <https://doi.org/10.1177/17562848221134396>
4. Leong, K. S. W., Derraik, J. G. B., Hofman, P. L., & Cutfield, W. S. (2018). Antibiotics, gut microbiome and obesity. *Clinical Endocrinology (Oxford)*, *88*(2), 185–200. <https://doi.org/10.1111/cen.13495>
5. Castaño-Rodríguez N, Underwood AP, Merif J, Riordan SM, Rawlinson WD, Mitchell HM, Kaakoush NO. 2018. Gut microbiome analysis identifies potential etiological factors in acute gastroenteritis. Infect Immun 86:e00060-18. H
6. Zheng, D., Liwinski, T. & Elinav, E. Interaction between microbiota and immunity in health and disease. Cell Res 30, 492–506 (2020). <https://doi.org/10.1038/s41422-020-0332-7>
7. The effect of antibiotics on the composition of the intestinal microbiota - a systematic review P Zimmermann; N Curtis. J Infect Vol. 79, (2019).
8. Cees, v. N. (2022). Antibiotic treatment of urinary tract infection and its impact on the gut microbiota.*The Lancet Infectious Diseases, 22*(3), 307-309.
9. Impact of broad spectrum antibiotics on the gut-microbiota-spleen-brain axis. Xiayun Wan et al; Brain, Behaviour and Immunity – Health 27 (2023)
10. Recovery of the Gut Microbiota after Antibiotics Depends on Host Diet, Community Context, and Environmental Reservoirs. (2019). Cell Host & Microbe. <https://doi.org/10.1016/j.chom.2019.10.011>

**What is the purpose of this guideline?**

Prevention of future infections is the main aim of this guideline. Infections can harm our long-term health by damaging our gut microbiome. Prevention of infection can protect our gut microbiome which in turn should protect us from future disease. By expanding the richness and diversity of our gut microbiota we stabilize it and make it more resilient to disease and we improve our immune protection.

**Mechanisms by which we can enhance our gut microbiome**

1. **Diet**

**Diversity of plants**

It is well accepted by microbiome scientists that consuming a diet high in plants with more than 30 different varieties of plants a week will expand the diversity of beneficial microorganisms in the gut microbiome. Plants include whole fruits, vegetables, seeds, nuts, wholegrains, pulses, herbs and spices. Plants are best consumed whole. When we process fruits and vegetables we alter the fibres in the plants which changes how we digest them and they can lose some of their potential benefits.

Plants contain fibre and polyphenols (natural antioxidants) which are highly anti-inflammatory and can feed the beneficial microorganisms in the gut. This enhances the production of essential nutrients called short chain fatty acids (SCFAs). SCFAs play wide ranging roles in our health from aiding vitamin, hormone and chemical messenger production, to improving our sugar and fat metabolism and protecting us from harmful infections. We need lots of SCFAs to stay healthy which is why we need a high fibre diet with lots of plants. Sadly a western diet is associated with low production of SCFAs.

Ref

1. Current explorations of nutrition and the gut microbiome: a comprehensive evaluation of the review literature. Leigh A Frame; Nutrition Review 2020 Oct 1; 78(10): 798-812
2. Peterson, C. T. et al. (2022) ‘Short-Chain Fatty Acids Modulate Healthy Gut Microbiota Composition and Functional Potential.’, Current microbiology, 79(5), p. 128. [doi: 10.1007/s00284-022-02825-5](https://pubmed.ncbi.nlm.nih.gov/35287182/" \t "_blank)
3. Elham Hosseini et al; Propionate as a health-promoting microbial metabolite in the human gut. Nutrition Reviews; Vol 69; Issue 5; May 2011; p. 245-258. Article.

**Fermented foods**

Fermented foods contain beneficial live bacteria (probiotics), and their food source (prebiotics). These foods help to expand the richness and diversity of species in the gut microbiome and can protect it from antibiotics. In addition, these beneficial bacteria help with the production of SCFAs and important immune cytokines.

Examples of fermented foods are: natural yogurts, kefir, kombucha, sauerkraut, kimchi and vegetables in brine. If you don’t like eating fermented foods, please consider taking a daily probiotic supplement.

Top tips

- Homemade fermented foods tend to provide more live bacteria and are much cheaper than shop bought versions.

- Unsweetened fermented dairy contains more bacteria than sweetened alternative.

Ref

1. Gut-Microbiota-targeted diets modulate human immune status; Wastyk HC et al; Cell 2021 Aug 5; 184(16);4137-4153.

**Ultra-processed foods (UPFs)**

UPFs are created in factories using ingredients you would not normally find in your store cupboard. These foods are generally high in fat, sugar, sweeteners and additives, for example emulsifiers. They are highly processed so are low in fibre and offer little nutritional benefit. They can be very damaging to our gut microbiome so are best avoided when trying to optimise gut health.

Ref

1. Processed foods drive intestinal barrier permeability and microvascular diseases. Melinda T. Coughlan et al; Sci Adv 2021 Mar; 7(14)

**Emulsifiers**

Emulsifiers are ingredients added to UPFs to prevent fat and water from separating. They thicken sauces and prevent them from splitting and are used in many different foods such as ice creams, non-butter spreads, sauces, chocolates, bread, salad dressings and many more. They are normally listed as emulsifiers but can also be called soy lecithin, carrageenan and gums.

Emulsifiers have a variable effect on the gut microbiome with some being more toxic than others, but the more emulsifiers in your diet the greater the impact they can have. Consider them similar to washing up liquid in your gut, washing away the protective mucous layer and damaging the gut wall leading to a leaky gut. This is a condition in which the lining of the gut becomes weakened and allows microbes, toxins and other molecules to pass into the bloodstream.

In addition, emulsifiers can supercharge certain bacteria making them more likely to cause infection. Removing them from your diet can help reduce recurrent infections especially from microorganisms like E. Coli which are often responsible for urinary tract infections.

Ref

1. Direct impact of commonly used dietary emulsifiers on human gut microbiota. Sabrine Naimi et al; Microbiome 9; Article No 66; 2021

**Sweeteners**

Sweeteners were thought to be more beneficial for our health than sugar, but more recent research has discovered that they are damaging to the gut microbiome, causing inflammation, erosion of the gut wall and DNA damage. They are best removed from your diet.

Ref

1. Artificial sweeteners: history and new concepts on inflammation. Abigail Raffner Basson et al; Nutrition 24/09/2021 Vol 8
2. Toxicological and pharmacokinetic properties of sucralose-6-acetate and its parent sucralose: in vitro screening assays. Susan S. Schiffman et al; J. of Toxicology and environmental Health; part B 2023
3. Aspartame – true or false? Narrative review of safety analysis and general use in products. Kamila Czarnecka et al; Nutrients 2021 Jun; 13(6):1957

**Sugar**

Sugar in high quantities can be very damaging for the gut microbiome encouraging the growth of harmful disease-causing bacteria and fungi, and damaging the population of beneficial microorganisms. This impact can increase your likelihood of developing more infections. It is best to minimise your sugar intake.

Ref

1. Satokari R. High Intake of Sugar and the Balance between Pro- and Anti-Inflammatory Gut Bacteria. Nutrients. 2020 May 8;12(5):1348. doi: 10.3390/nu12051348. PMID: 32397233; PMCID: PMC7284805.

**Fat**

Fat is essential for the creation of all the cells in our body. Many vitamins are delivered to us in fats, for example Vitamin A, D, E and K. There are also many important fats essential for our health such as Omega 3 fatty acids present in extra virgin olive oil, fish oils, avocado and meats. There are some other types of fats which especially in high amounts can increase inflammation in our gut microbiome. Examples of these fats are found in palm oils, processed seed oils, hydrogenated fats and saturated fats especially in intensively reared animals and UPFs. These types of fats are best to be avoided.

Ref

1. Alterations in gut microbiota and immunity by dietary fat. Bo-Gie Yang et al; Yonsei Med J. 2017 Nov; 58(6): 1083-1091

**Vitamin D**

Whilst we get some vitamin D from foods (Eg mushrooms and dairy) we cannot get sufficient vitamin D for our body this way. In hot, sunny countries we would glean all the vitamin D we require from the sun. Sadly, in the UK without supplements most of us would be vitamin D deficient unless travelling abroad frequently. Vitamin D is an essential hormone for our immune system and deficiency of this hormone leads to a greater incidence of infections, more severe infections and is associated with greater incidence of cancer.

An adult in the UK should take up to 4000units daily to maintain sufficient vitamin D levels.

1. Schwalfenberg, G.K. (2011), A review of the critical role of vitamin D in the functioning of the immune system and the clinical implications of vitamin D deficiency. Mol. Nutr. Food Res., 55: 96-108. <https://doi-org.knowledge.idm.oclc.org/10.1002/mnfr.201000174>
2. **Sleep**

Sleep is an essential pillar of lifestyle medicine. We repair at night and a healthy sleep cycle helps reduce our likelihood of catching infections. Healthy sleep also hastens our recovery from infection and helps us respond better after vaccines. An adult should get 7-9 hours of uninterrupted sleep per night. If you are struggling with your sleep please consult resources such as:

* <https://thesleepcharity.org.uk/>
* The Sleepio app

1. Why we sleep; Matthew Walker Penguin press 2017
2. Opp, M. R. (2023). Sleep: Not getting enough diminishes vaccine responses. *Current Biology*, *33*(5), R192–R194. <https://doi.org/10.1016/j.cub.2023.02.003>
3. Ibarra-Coronado, E. G., Pantaleón-Martínez, A. M., Velazquéz-Moctezuma, J., Prospéro-García, O., Méndez-Díaz, M., Pérez-Tapia, M., Pavón, L., & Morales-Montor, J. (2015). The Bidirectional Relationship between Sleep and Immunity against Infections. *Journal of Immunology Research*, *2015*, 678164–14. https://doi.org/10.1155/2015/678164
4. **Exercise**

Regular exercise improves our heart and lung function, our muscle and joint strength and our immune function. Exercise enhances our sleep and mood and if we exercise outside in nature we receive the additional health benefits of sun exposure and contact with beneficial microorganisms in the air and soil which can help us expand our gut microbiome.

Being inactive is associated with poorer health and an increased risk of infection and chronic disease. Being sedentary increases our likelihood of requiring medications.

Current guidelines for exercise are 150 minutes per week for an adult with 75 minutes being devoted to strength building. This is a minimum requirement and we would recommend start gradually and build exercise over time aiming to go beyond these recommendations for even greater health benefits.

Ref

1. Exercise and the gut microbiome: A review of the evidence, potential mechanisms and implications for human health. Lucy J. Mailing et al; Exercise & Sports Sciences Review; Apr 2019; Vol 47; Iss 2; p75-85

**Unhealthy Habits**

**Smoking/vaping**

Smoking and vaping damage the lining of the lung and alter the lung microbiome, which increases your likelihood of developing respiratory infections and long term damage to the lungs. For help with smoking cessation please attend your local pharmacy or visit the NHS website to find your local Quit Your Way support - <https://www.nhsinform.scot/healthy-living/stopping-smoking/help-to-stop/local-help-to-stop-smoking/>

**Alcohol**

Alcohol can damage the gut microbiome by encouraging harmful microorganisms to thrive and also reducing the numbers of beneficial microorganisms present. Try to keep alcohol to a minimum, sticking to the recommended guidelines of14 units or less per week. For help with alcohol dependence please contact your local AA - <https://www.alcoholics-anonymous.org.uk/>

Ref

1. Alcohol and gut derived inflammation Faraz Bishehsari et al; Alcohol Research 2017; 38(2):163-171

**Stress**

We can all suffer from periods of stress in our lives. Short bursts of stress caused by stressful life events can cause temporary perturbations in the health of our gut microbiome. Stress hormones create inflammation in the body and disruption of sleep which negatively impacts our gut microbiome. These short-term perturbations should be easy for us to recover from, however when stress becomes chronic (drags on for a few months or more) the impact on our gut microbiome is much greater. Many people are suffering from chronic stress through work, social or financial difficulties and these can be harder problems to solve. The first step is recognition of stress then we can consider how best to resolve it. For help managing stress consult your work or GP surgery to find out about stress management courses.

Ref

1. Zefferino, R., Di Gioia, S., & Conese, M. (2021). Molecular links between endocrine, nervous and immune system during chronic stress. *Brain and Behavior*, *11*(2), e01960-n/a. https://doi.org/10.1002/brb3.1960

**Relationships**

Healthy, loving relationships with friends, family and partners can support our health through the reduction of stress, production of beneficial hormones such as oxytocin and through improving mood and happiness. Healthy relationships are associated with a healthier gut microbiome. In contrast unhealthy relationships can drive stress and unhappiness and lead to unhealthy habits (For example drinking, smoking and drug use) and destruction of the gut microbiome.