of public attention and this may account for some of its popularity.

We also looked at what sections of the topics received most views. The sections of the topics with the most page views suggest a clear pattern of usage. The top two sections include the topic homepage and the "highlights-summary" page. However, this is to be expected as these are the first pages that users land on when they go to a topic.

Where they go next is of more interest; and here there are clear messages from the data. Six of the next ten most popular sections relate to diagnosis – these include the sections on "approach to diagnosis", "history and examination", "differential diagnosis", "investigations", "diagnosis: step-by-step" and "case history".[4] Of the remaining, three relate to issues in management. These include the sections on "treatment options", "treatment details", and "approach to management".

The data suggests that users are utilising the clinical decision support tool to aid their decisions in diagnosis and management of notifiable viral infectious diseases and that they need help in the basics of taking a history, conducting an examination, ordering tests and ruling in or out differential diagnoses.[5] Equally it may be that they want to confirm what they are doing is correct. The usage behaviour is largely related to the clinical workflow and suggests that users are using the tool at the point-of-care and not as a referential source that they might look at after the clinical event.

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REFERENCES

1. Kwag KH, González-Lorenzo M, Banzi R, Bonovas S, Moja L. Providing doctors with high-quality information: an updated evaluation of web-based point-of-care information summaries. *J Med Internet Res*. 2016;18(1):e15.
2. Walsh K. Online clinical decision support: how it is used at the point-of-care. *BMJ Simul Tech Enhanc Learn*. 2017;3(2):73-4
3. Islam R, Weir CR, Jones M, Del Fiol G, Samore MH. Understanding complex clinical reasoning in infectious diseases for improving clinical decision support design. *BMC Med Inform Decis Mak*. 2015;15:101.
4. Gov.Uk [Internet]. Guidance: Notifiable diseases and causative organisms: how to report. London: Public Health England; 2019. Available from: https://www.gov.uk/guidance/notifiable-diseases-and-causative-organisms-how-to-report#list-of-notifiable-diseases [Accessed Feb 2019]
5. Gov.Uk [Internet]. Research and analysis: notifiable diseases: historic annual totals. Cases of infectious diseases: annual total figures from 1912 to 2017. London: Public Health England; 2018. Available from: https://www.gov.uk/government/publications/notifiable-diseases-historic-annual-totals. [Accessed Feb 2019]

ANTIMICROBIAL PROPERTIES OF NATIVE ULSTER MACROFUNGI (MUSHROOMS AND TOADSTOOLS) TO CLINICAL PATHOGENS

Editor,

Previously, our research group has reported in the *UMJ* on various traditional Ulster cures and remedies (January 2009)[1] and on the physiological basis of the antibacterial activity emulating such cures and remedies (January 2009)[2]. In addition, we have examined the antimicrobial properties of sphagnum moss and its role in the Great War 1914-1918, relating to bandage preparation and wound dressings.[3] To date, we have not examined the antimicrobial properties of native macrofungi, namely the mushrooms and toadstools and therefore, it was the aim of the current study to examine the activity of native Ulster macrofungi on clinical bacterial and fungal pathogens.

Fig1a Coprinus comatus: Dick Culbert, B.C., Canada

Twenty-two species of native macrofungi were collected from woodlands throughout Northern Ireland (Table 1). *Lentinula edodes* (Shiitake mushroom) was also examined, given its popularity as a constituent of Asian (mainly Japanese) cuisine. Formal identification of all macrofungi examined was made by PCR-DNA techniques, employing fungal 18S rDNA universal ITS 1 and ITS 4 primers (ITS1: TCC GTA GTT GAA CCT GCG G and ITS4: TCC TCC GCT TAT TGA TAT GC). Aqueous and protein extracts (approx.1mg/ml) were obtained from freeze-dried preparations of each fungus. Six bacterial and one fungal pathogen were examined

in this study (Table 1), including the Gram-positive bacteria (*Bacillus cereus, Listeria monocytogenes, Staphylococcus aureus* (methicillin-sensitive), *Staphylococcus aureus* (methicillin-resistant), the Gram-negative bacteria (*E. coli* O157, *Klebsiella aerogenes*, *Pseudomonas aeruginosa*) and the fungal pathogen, *Aspergillus flavus*. All isolates were obtained from the HSC MicroARK Northern Ireland Microbiology Repository, located at the Northern Ireland Public Health Laboratory, Belfast City Hospital (www.microark.com). Antimicrobial properties were determined on each fungal extract/pathogen combination by standard disk diffusion assay.

All native fungi, except for *Agaricus bisporus* (the common mushroom) demonstrated antimicrobial activity against at least one of the extracts to one of the clinical pathogens tested (Table 1). Two native fungi, *Coprinus comatus* and *Leucopaxillus tricolor* were active against all of the pathogens tested. *Lentinula edodes* (Shiitake mushroom) was also active against all of the pathogens tested. Overall, aqueous extracts were more antimicrobial than the protein extracts examined.

Coprinus comatus is commonly seen in Northern Ireland (Figure 1a) and is sometimes known as shaggy ink cap, lawyer's wig, or shaggy mane, due to the white cap of the fungus being covered in scales. Other recent studies have also shown this fungal species to exhibit potent antimicrobial properties.[4] *Leucopaxillus tricolor* (Figure 1b) is found

TABLE 1:

Antimicrobial activity of aqueous and protein extracts of 23 macrofungi against clinical pathogens

	Aqueous Extract	PPER* Extract
Agaricus augustus		*Listeria monocytogenes*
Agaricus bisporus		
Amanita sp.	*Staphylococcus aureus, MRSA***	
Boletus chrysenteron	*Staphylococcus aureus*	*Listeria monocytogenes*
Clitocybe sp.	*Staphylococcus aureus, MRSA*	*Listeria monocytogenes*
Coprinus comatus	*Bacillus cereus, E. coli O157, Klebsiella pneumoniae Listeria monocytogenes, MRSA, Pseudomonas aeruginosa*	
Gymnopilus junonius	*Klebsiella pneumonia, Listeria monocytogenes, MRSA*	*Listeria monocytogenes*
Gymnopus confluens		*Listeria monocytogenes*
Hygrocybe nigrescens		*Listeria monocytogenes, Aspergillus flavus, E. coli O157*
Hypholoma fascicularis	*Listeria monocytogenes*	
Inocybe geophylla	*Staphylococcus aureus*	*Listeria monocytogenes, Aspergillus flavus*
Laccaria amethystine	*Staphylococcus aureus, MRSA*	
Lentinula edodes	*Aspergillus flavus, Bacillus cereus, E. coli O157, Klebsiella pneumoniae, Listeria monocytogenes, MRSA, Pseudomonas aeruginosa*	
Leucopaxillus tricolor	*Bacillus cereus, E. coli O157, Klebsiella pneumoniae, Listeria monocytogenes, MRSA, Pseudomonas aeruginosa, Staphylococcus aureus*	*Aspergillus flavus Listeria monocytogenes*
Mycena rosea	*MRSA, Staphylococcus aureus*	*Aspergillus flavus, E. coli O157, Listeria monocytogenes*
Mycena sp.		*E. coli O157, Listeria monocytogenes*
Psathyrella candolleana	*Bacillus cereus*	
Pseudotrametes gibbosa	*MRSA, Staphylococcus aureus*	
Russula cyanoxantha		*Aspergillus flavus, Listeria monocytogenes*
Russula nigricans	*MRSA, Staphylococcus aureus*	
Russula parazurea		*Listeria monocytogenes*
Russula sp.		*Listeria monocytogenes*
Trametes versicolor	*MRSA, Staphylococcus aureus*	

Where no value is recorded there was no inhibition in any of the clinical pathogens tested
*PPER = Plant Protein Extraction Reagent
**MRSA = methicillin-resistant Staphylococcus aureus

growing in woodland litter and is composed of three coloured components, namely a brown cap, yellow gills and a white stem, hence the epiphet name, *tricolor*. *Lentinula edodes* (Figure 1c) is a common constituent of Asian cuisine and has been shown previously to have antimicrobial properties.

Fig 1b Leucopaxillus tricolor: Eva Skific (Evica)

Antimicrobial resistance (AMR) has now emerged as a major global public health problem. Locally in Northern Ireland, the extremes of AMR manifest as multi- and pan-resistant Gram-negative respiratory infections in patients with cystic fibrosis (CF), particularly associated with *Pseudomonas aeruginosa* and *Burkholderia cenocepacia,* which can cause a treatment dilemma due to a shortage of active antibiotics.

In conclusion, this study has identified extracts from native local macrofungal species to have an antimicrobial activity against several clinical pathogens. Given the need to search for novel antimicrobial compounds coupled with the agrarian background of Northern Ireland's economy, further work should be undertaken to identify other local sources of antimicrobials and a mechanism established amongst the relevant government agencies, academia and patient groups, to help such novel compounds enter into the drug discovery pathway, so that any potential medicinal value can be fully exploited.

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Fig 1c Lentinula edodes: Fankenstoen from Portland, Oregon, USA

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REFERENCES

1 Ballard LM. An approach to traditional cures in Ulster. *Ulster Med J*. 2009;**78(1)**:26-33.

2 Woods-Panzaru S, Nelson D, McCollum G, Ballard LM, Millar BC, Maeda Y, *et al*. An examination of antibacterial and antifungal properties of constituents described in traditional Ulster cures and remedies. *Ulster Med J*. 2009; **78(1):**13-5.

3 Moore PJ, Rao JR, Nelson D, McCollum G, Ballard LM, Millar BC, *et al*. Examination of the antibacterial properties of sphagnum moss (Sphagnum spp.) and its significance with turf burning in Ireland. *Br J Biomed Sci*. 2012;**69(4):**178-80.

4 Stojković D, Reis FS, Barros L, Glamočlija J, Ćirić A, van Griensven LJ, *et al*. Nutrients and non-nutrients composition and bioactivity of wild and cultivated *Coprinus comatus* (O.F.Müll.) Pers. *Food Chem Toxicol*. 2013;**59**:289-96.