Overview of e-Bug: an antibiotic and hygiene educational resource for schools

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Antibiotic resistance is an increasing community problem and is related to antibiotic use. If antibiotic use could be reduced, the tide of increasing resistance could be stemmed. e-Bug is a European project involving 18 European countries, partly funded by The Directorate-General for Health and Consumers (DG SANCO) of the European Commission. It aims to develop and disseminate across Europe a junior and senior school teaching pack and web site (hosting the lesson plans and complementary games) that teach young people about prudent antibiotic use, microbes, transmission of infection, hygiene and vaccines. The aim of e-Bug is to increase young people's understanding, through enjoyable activities, of why it is so important to use antibiotics correctly in order to control antibiotic resistance, and to have good hand and respiratory hygiene to help reduce the spread of infection. Within the senior school pack the sexual transmission of infections has also been included, as the peak age of chlamydial infection is in 16 – 24 year olds. Teachers, young people and the con- sortium of 18 countries were closely involved with agreeing learning outcomes and developing the resource activities. Young people helped create the characters and microbe artwork. The resources have been translated, adapted for and disseminated to schools across 10 countries in Europe, and endorsed by the relevant govern- ment departments of health and education. The web site has been accessed from ~200 countries. The resources will be translated into all European Union languages, and have been used to promote European Anti- biotic Awareness Day and better hand and respiratory hygiene during the influenza pandemic in 2009.

Keywords: antibiotics, resistance, schools, Europe, websites, education

Introduction

Resistance to antibiotics is now recognized worldwide as a major threat to public health. The European Health Council continues to highlight that 'antimicrobial resistance is still a growing health problem, which increases morbidity and mortality and leads to a diminution in the quality of life, as well as additional health and medicinal costs'.[1] Resistance is no longer just a hospital problem, it is an increasing therapeutic problem in the community. Antibiotic resistance rates are related to antibiotic use.[2,3] Reducing antibiotic use may stem the tide of increasing antibiotic resistance.[4] Across the European Union (EU) there is a wide variation in antibiotic use in both the hospital and community settings. Total outpatient antibiotic use across the EU in 2007 varied by a factor of about three between the country with the highest use [34 defined daily doses (DDD) per thousand population in Cyprus] and the country with the lowest use (11 DDD per thousand population in the Netherlands).[5] Those countries with higher antibiotic use also, generally, have higher resistance rates.[6] With increasing holiday and commercial

travel between all European countries, antibiotic-resistant organisms can easily spread from one EU country to another. Therefore, even those countries with low antibiotic use will wish that antibiotic use is controlled across the EU and beyond. This explains why the EU Commission and the World Health Organization (WHO) have stressed the importance of both professional and public involvement in the control of antibiotic resistance through prudent antibiotic use.[7] Within the community, the public play a very important part in the control of antibiotic use.[8] Several studies have shown that the biggest predictor of an antibiotic prescription in the community is the patient's consultation behaviour, expectation for antibiotics and number of previous antibiotic prescriptions.[9,10] This overexpectation for antibiotics may be due to the public's misunderstanding about the activity of antibiotics against microbes and their prudent use, and recent European surveys have confirmed this.[11,12]

Why teach young people about antibiotic use?

Antibiotics are the most common medicines given to children and, in many European countries, antibiotic prescription rates are highest in this group.[7] In the UK there are ~6 million antibiotic prescriptions for children each year, the majority being given for viral upper respiratory tract infections.[13] An individual's consulting behaviour and personal attitude to antibiotic use are probably shaped early in life when they are taken to their doctor during childhood and adolescence. In a large British survey, 16 – 24 year olds were less knowledgeable about antibiotics than any other age group, except those ≥75 years old;[14] therefore, teaching young people about the role of antibiotics and microbes in schools may help to shape these attitudes. e-Bug does not aim to make young people into 'young clinicians', but aims to help them to be informed so that our future generation of antibiotic users will use antibiotics only when appropriate and as instructed.

Why teach young people about hygiene?

Respiratory and gastrointestinal diseases cause a significant burden in terms of school absenteeism of young people, and in lost work days of parents caring for them.[15] The spread of infections in schools also accounts for a significant amount of absence due to illness in teachers and carers.[16] Schools are ideal environments for the spread of infections, as young people have close contact over long periods of the day and many have poor standards of personal hygiene. Furthermore, school children often lack immunity to many of the common infections circulating in this setting. Reducing the burden of infections in the school community through improved hygiene could not only reduce absenteeism, but also reduce the antibiotic use associated with these infections.

Handwashing is the most effective way of reducing the burden of infections; however, handwashing after toilet use is very low in most school-age children.[17] There is 100% compliance in young school children when they are accompanied to the toilet and instructed to wash their hands. Handwashing rates drop to 80% in junior school and to 40% in senior school.[17] Children with a good knowledge of handwashing and hygiene have less faecal contamination of their hands.[18] Handwashing education with the use of a frothy liquid showed increased compliance in primary school children before eating and after toilet use.[19] A study looking at a structured handwashing programme in an elementary school found that gastrointestinal infections fell, but reductions in respiratory infections in the study group were not statistically significant.[20] Another study in a Chicago elementary school evaluating handwashing educational activities similar to e-Bug and unsupervised handwashing using the usual school soap and cold water taps, found that absenteeism in non-participating classes owing to respiratory illness was double during the 2 months immediately after the intervention compared with in participating classrooms,[21] but this difference did not persist into the third month when the flu season peaked. The difference was not significant during the influenza season. Other school hygiene campaigns using hand sanitizers have reduced rates of infection in school children, staff and their families.[22–24]

Epidemiological analysis of the pandemic influenza outbreak indicated that children appeared to be more susceptible to acquiring infection and more infectious to others. During seasonal influenza, as well as during the 2009 pandemic, children have played an important role in spreading the virus due to various factors, including respiratory hygiene. The spread of influenza and other respiratory infections can be limited through basic respiratory hygiene, including covering the nose and mouth when coughing or sneezing, using a tissue, and disposing of dirty tissues promptly and carefully.

Why teach young people about sexual health?

Numbers and rates of acute sexually transmitted infections (STIs) in many EU countries have increased since the mid-1990s.[25] Genital chlamydia infection is now among the most commonly diagnosed bacterial STI in Europe and the great- est disease burden is in young women aged 16 – 19 years. Infection rates are greatest in young people with a higher prevalence of risk behaviours and generally poor access to culturally appropriate STI prevention and treatment services.[25] It is, therefore, sensible to cover sexual transmission of infections in the school curriculum before students reach the peak age of chlamydia disease burden.

What is e-Bug?

e-Bug is an EU project that aims to develop and disseminate, across Europe, a junior and senior school educational resource for teachers covering microbes, hygiene, antibiotics and prevention of infection. An educational pack containing fun lesson plans and activities is accompanied by a web site hosting the lesson plans and complementary games for young people and their families to play in the classroom or at home. The project is led by the HPA Primary Care Unit in Gloucester, UK and involves a consortium of 18 European partner countries. The project was 60% funded by The Directorate-General for Health and Consumers (DG SANCO) of the European Commission until December 2009, and is now supported by the HPA, England and the European Centre for Disease Prevention and Control (ECDC).

Figure 1. e-Bug logo.

How has e-Bug been developed?

The project name and logo were the earliest things to be created. The 'e' in the e-Bug logo (Figure 1) and the European stars around it convey the ideas that the web site is European, educational and electronic. The 'eu' domain also conveys that e-Bug is a European project. The 'e' microbe-shaped logo was then derived from the 'e' of the web address, and was in-filled with the European blue, and eyes and microbial 'projections' were added to communicate that the project involved microbes and was fun. Searching via Google in 2010 for 'e-Bug' or 'bug EU' lists the www.e-Bug.eu web site at the top of the search results.

To tackle the problem of antimicrobial resistance across the EU, e-Bug recognizes the importance of European partner cooperation. To attain this, the e-Bug project commenced with an interactive meeting, in London in September 2006, involving all the associate partners. At this meeting a questionnaire was agreed to determine school and cultural factors, and the content of any national campaigns that may have an impact on the educational resource and implementation in the partners' countries. This questionnaire showed that in most countries 9– 11 and 13– 15 year olds were taught about microbes within an obligatory science curriculum: these age groups were considered the most appropriate across Europe at which to aim the pack.[26] The school curricula in all partner countries cover basic human health, microbes and hygiene, but few countries cover antibiotic resistance,[27] so a resource covering antibiotic resistance is needed across Europe.

The different draft activities were discussed, in detail, with teachers, representatives and stakeholders from the 18 partner countries. The activity areas (Table 1), learning outcomes and key messages for a series of junior (9 – 11 year old) and senior school (12– 15 year old) student lesson plans and activities were agreed. Within the e-Bug junior and senior pack and games, an introduction to microbes and hand hygiene is taught through fun activities. Within the junior school setting, e-Bug also teaches about the importance of hygiene during food preparation, as food-related infectious intestinal disease is extremely common. Respiratory hygiene is taught through a fun activity now familiarly called the 'snot gun'. In senior schools, the importance of safe sex is reinforced by demonstrating how a sexually transmitted infection could spread widely within a group of young people who do not practise it. Both packs also cover antibiotic use and vaccines. To reinforce learning, many of the core messages in the senior school pack are the same as in the junior school pack, but the senior school pack also incorporates different activities and explores the issues in much greater depth. To allow for a range of abilities within a school, or in each class or in home-based work, extension activities are always included in each lesson plan.

Focus groups held with school teachers in the UK and France helped us to gain a comprehensive insight into the microbiology and health issues taught to the target age groups, and to establish teaching requirements and styles for e-Bug. During pack and web site development, the artists and resource developers worked closely with young people and teachers to perfect the characters and activities.[26] The junior school pack features cartoon microbes and artwork of children of the appropriate age. The senior school pack was designed as an evolution of the junior pack, where the characters have grown up and the microbes are more realistic. The graphic design and layout of the senior pack has a more adult content, and the activities are more factual and research based, to link with the higher National Curriculum requirements.

How was the e-Bug web site developed?

It would have been very expensive to distribute free e-Bug packs to all schools across Europe and beyond; therefore, it was agreed that aweb sitewould be used to increase dissemination and to conserve resources. The e-Bug web site (www.e-Bug.eu), developed at City University in London, contains all the pack materials, which can be downloaded directly by teachers without access to a hard copy of the pack, as well as presentations for teacher use, video clips of pack activities and student computer games. In the junior platform game, participants learn through fun. The pack characters Amy and Harry take photographs of microbes, wash microbes away, make yogurt and learn to always finish their course of antibiotics.[28] The game consists of a number of play levels, each of which promotes the same set of learning outcomes as in the junior pack activities. The senior game has an investigative format, where players investigate the cause of infectious illness in a movie star, and a soccer team and their trainer. There are four missions, with learning outcomes, covering hand and food hygiene, antibiotic resistance and how it can be related to antibiotic overuse, and the importance of taking antibiotics as instructed.

Translation and implementation

The e-Bug resources were extensively trialled with teachers, and junior and senior students in six regions across the Czech Republic, France and England during the 2008– 09 academic year, and modified again before translation into other languages. Translation of the resources and determining where they fit into educational curricula of the various countries was a critical step for the implementation of e-Bug. The 10 associate partner countries (Belgium, Czech Republic, Denmark, France, England, Greece, Italy, Poland, Portugal and Spain) were funded to translate and implement the resources in 2009 (Figure 2). These countries cover ~300 million people (55% of the total European population) and deliver school education to some of the highest users of antibioticsinthe EU. Countriessoughtendorsementfromtheirgovernment departments of health and education, which facilitated implementation in each country.[29– 38] Printing was partly or totally funded by these departments in each associate country and the packs were distributed free to schools. In some countries the activities were modified slightly to comply with educational regulations or to obtain government endorsement. Each country developed theirownimplementation plan, whichincluded obtaining endorsement, product launch, distribution, and marketing to

Table 1. Content of the e-Bug junior and senior packs

Pack content	Learning outcomes	
	junior	senior
Micro-organisms		
1.1 An Introduction: Students learn about the different types, shapes and sizes of microbes – bacteria, virus and fungi, and where microbes are found.	All students: • Will understand/know that there are three types of microbe – bacteria, viruses and fungi • Will understand/know that microbes are found everywhere More able students: • Will understand that microbes comes in different sizes	All students: • Will understand/know that there are three types of microbe – bacteria, viruses and fungi • Will understand/know that microbes are found everywhere More able students: • Will know that useful bacteria are found in ourbody • Will understand that microbes comes in different sizes
1.2 Useful Microbes: Students learn that microbes can be beneficial through a yeast or yogurt making experiment.	All students: • Will understand that some microbes can help keepus healthy • Will know that some microbes can be put to good use	All students: • Will understand that useful microbes can help keep us healthy • Will know that most microbes are beneficial to us • Will know that microbes can be put to good use More able students: • Will understand that we need bacterial colonization to live a healthy life • Will know that we need to protect our normal microbial flora
1.3 Harmful Microbes: Close examination of various illnesses illustrates to students how and where harmful microbes cause disease.	All students: • Will know that sometimes microbes can make us ill	All students: • Will know that sometimes microbes can make us ill
Spread of infection		
2.1 Hand Hygiene: Through a classroom experiment students learn how microbes can spread from one person to another through touch and why it is important to wash hands properly.	All students: • Will understand that infection can be spread through unclean hands • Will know that hand washing can prevent the spread of infection	All students: • Will understand that sometimes microbes can make us ill • Will know that prevention of infection, where possible, is better than cure • Will understand not to spread their harmful microbes to others • Will know how, when and why to wash their hands

2.2 Respiratory Hygiene: In this fun experiment students recreate a giant sneeze to learn how easily microbes can be spread through coughs and sneezes	All students: • Will learn that infection can spread through sneezing and coughing • Will understand that covering the mouth when sneezing or coughing can prevent the spread of infection More able students: • Will know that coughing or sneezing in your hand can still spread infection	All students: • Will understand that sometimes microbes can make us ill • Will know that prevention of infection, where possible, is better than cure • Will understand not to spread their harmful microbes to others • Will learn that infection can spread through sneezing and coughing • Will understand that covering the mouth with a tissue when sneezing or coughing can prevent the spread of infection More able students: • Will know that coughing or sneezing in your hand can still spread infection
2.3 Food Hygiene: Junior school children make a chicken salad for their classmates and observe just how far they have spread harmful microbes.	All students: • Will learn that microbes can be found on our food and can transfer to humans • Will learn that cooking food can kill harmful microbes • Will learn that bacterial multiply very quickly More able students: • Will learn that refrigeration only stops microbes growing; it doesn't kill them	
2.4 Sexual Transmission: Senior school students carry out a chemical experiment to observe how easily many people can become infected unknowingly by unprotected sexual intercourse.		All students: • Will know that infection can be spread easily through sexual contact • Will understand what they can do to protect themselves against STIs
Prevention of infection		
3.1 The Body's Natural Defences: Presentations and animations are used to show how the body fights harmful microbes on a daily basis.	All students: • Will learn that the human body has many natural defences to fight infection • Will learn that our bodies have three main lines of natural defences • Will learn that sometimes the body needs help to fight infection	All students: • Will learn that the human body has many natural defences to fight infection • Will learn that our bodies have three main lines of natural defences • Will learn that sometimes the body needs help to fight infection

Continued

Table 1. *Continued*

Pack content	Learning outcomes	
	junior	senior
3.2 Vaccinations: Students use their reading comprehension and creative skills to answer questions on and act out the discovery of vaccinations. Senior school students learn how vaccinations help protect the population during epidemics.	All students: • Will learn that vaccines help prevent a range of infections, including the flu More able students: • There are not vaccines for all infections	All students: • Will discover that vaccines help prevent a range of bacterial and viral infections • Will understand that there are not vaccines for all infections More able students: • Will learn that previously common infections are now rare due to vaccines • Will know that the most common infections such as the common cold or sore throat are not prevented by vaccines
Treatment of Infection 4.1 Antibiotic Use: Through teacher-led discussion and debate, and experiments in senior schools, students learn the importance of using antibiotics and other medicines appropriately.	All students: • Will understand/learn that most common infections get better on their own through time, bed rest, liquid intake and healthy living • Will understand/learn that if antibiotics are taken, it is important to finish the course	All students: • Will understand/learn that most common infections get better on their own through time, bed rest, liquid intake and healthy living • Will understand/learn that if antibiotics are taken, it is important to finish the course • Do not use other peoples or leftover antibiotics More able students: • Will learn that overuse of antibiotics can damage our normal/useful bacteria • Will learn bacteria are becoming resistant to antibiotics due to overuse

Figure 2. Countries so far involved in the e-Bug project.

stakeholdersineducationandpublic health. All thepackmaterials, videos of the activities, alternative activities and extension activities are now available on the e-Bug web site in the 10 languages: Czech, Danish, English, Flemish, French, Greek, Italian, Polish, Portuguese and Spanish.

Eight other collaborating countries with a population of 37 million (Croatia, Finland, Hungary, Ireland, Latvia, Lithuania, Slovakia and Slovenia) have been involved in pack development, but received no additional funding from the European Commission for translation and implementation. The e-Bug pack and web site was launched by Dr David Heymann, WHO Assistant Director-General for Health Security and Environment and Chairman of the English HPA Board, at a meeting of all 18 countries in London in September 2009.

Since the launch of the project, many other European countries and the devolved nations within the United Kingdom have expressed interest in becoming involved in the project, with populations of at least another 150 million. ECDC has agreed to translate the packs and web site materials into all the EU countries' languages, and the HPA in England has agreed to support the web site. This is a very important commitment from the HPA and ECDC, and has allowed e-Bug to continue beyond 2009 and expand. The e-Bug resources were used by many countries to support the public health response for schools during the 2009 influenza pandemic. Specific school student fact sheets for notice boards were designed and posted on the web in May 2009 with a link from the HPA web site. These were the most commonly downloaded e-Bug materials.[39]

How does e-Bug fit into public antibiotic campaigns?

To address the expectation for antibiotics, several countries have undertaken successful antibiotic campaigns.[40] Some campaigns

have also taught the importance of handwashing in preventing the spread of infection and, therefore, reducing antibiotic use.[40] The success of national awareness campaigns stimulated a European initiative coordinated by ECDC and named 'European Antibiotic Awareness Day' (EAAD) to take place each year on 18 November.[41] The first campaign in 2008 was focused on parents and carers of children aged 1 – 6 years, and the key message was about not taking antibiotics for viral infections, such as colds and influenza. The EAAD web site posted a film that gave a 5 min overview of the threat posed by antibiotic resistance and the strategies to keep antibiotics effective for the use of future generations. This film had a section on the development of e-Bug and featured one of the English schools where the resources were trialled. Many of the associate countries used EAAD in 2008 and 2009 to promote e-Bug. Several countries ran school-based poster competitions around the antibiotic activities in e-Bug or sent the antibiotic activity as a separate booklet to schools in time for EAAD. Some countries also developed extra antibiotic-related activities to take e-Bug out into the home environment.

In 2010, as part of EAAD, ECDC will provide a translation of the e-Bug pack and web site so that the resources are made available to all the EU-27 countries and the three EU candidate countries (Iceland, Croatia and Norway). Each country will fit translations into the e-Bug pack template, and provide appropriate curriculum details and any links to local educational and health websites.

Extending e-Bug to a wider audience

The e-Bug resources can be adapted easily to suit many other audiences in the public, educational and healthcare settings. In England, Italy and Greece, partners have taken the e-Bug activities out to science fairs and other venues, including holiday camps. At science fairs, e-Bug activities help families to learn together through enquiry-based learning; enabling the learning to reach both young people outside the age range of e-Bug for schools and adults from a range of socioeconomic groups. This is a possible future adaptation of e-Bug. Each country across Europe could work with other public health stakeholders to develop the activities to suit different audiences. This could especially target areas of high antibiotic use or socioeconomic deprivation.

The sexual health section in the senior school pack could be extended to complement sexual relationship educational curricula in schools, so that e-Bug could contribute to reducing sexually transmitted infections and pregnancy in teenagers.

Can e-Bug be considered successful and if so how was this attained?

It is difficult to determine the true success of the e-Bug project without a formal process evaluation of its implementation and an evaluation of any change in behaviour or attitudes of young people after being taught with e-Bug. However, other criteria can be used to determine the success of the development, translation and implementation of e-Bug across Europe. Firstly, all 18 partner countries agreed on the pack content and learning outcomes, facilitating the development of a common product across Europe. Each country gained a real feeling of ownership of e-Bug during the 9 month research period, which allowed involvement of all partners in producing ideas for and discussing and trialling different activities for the project's resources. Secondly, as junior and senior students were asked about their opinion of human and microbe characters at every stage of development, informal discussions with students involved in the development and evaluation indicated that the resulting artwork appealed to each age group. The formal evaluation, with ~1000 students in three countries (reported separately),[42] showed that the majority of teachers and students enjoyed the activities, and that the majority of teachers would use the resources again. Furthermore, this evaluation showed that student knowledge improved significantly after using the packs' resources.[42] Additionally, teachers were closely involved with informing the requirements and development of all the resources over a year; a luxury that is not usually afforded to commercial educational product development. The early evaluation allowed more changes to the activities to be made before the product was finally launched. Thirdly, all 10 associate partners have now attained endorsement from their government departments of health and education; many packs have government logos on the covers, which is quite unusual in this type of school educational resource. This endorsement by the major stakeholders in their countries was instrumental in attaining widespread implementation in schools. Fourthly, the European Commission and ECDC have been very supportive throughout the project, and have fully endorsed the resources and funded further translations, facilitating greater dissemination across Europe.

The future of e-Bug

Further qualitative and quantitative evaluation of the modified antibiotic and vaccine sections of the e-Bug resources would be very valuable. After the resources have been available for a year it will be important to determine, through teacher surveys, how much they are being used across Europe. The analysis of web page usage and web resource downloads will be valuable in providing information on the use of the materials and web site games.[39] The games will be further evaluated and any modifications will be uploaded to the e-Bug web site. Although the evaluation demonstrated that the class activities improve knowledge and are enjoyed by young people,[42] the effect on young people's hygiene practices, future attitudes to antibiotic use or school absenteeism has not been determined. To determine this will require further qualitative work or a large randomized controlled trial with appropriate funding.

e-Bug, like microbes themselves, must adapt to the ever-changing European educational and antibiotic resistance environment. For the longer term sustainability of the project, the web site is being transferred to the HPA in England, which has agreed to host and support all EU country websites and the project team. The e-Bug project management team, based in the HPA, will be working with the current and future e-Bug partners to take the project forward. Project partner and stakeholder ideas on how to develop the web site include a log on for students, so that they can feel ownership of their site, the creation of avatars to guide students through different sections of the web site, downloadable clipart of pack artwork and photographs of

microbes to usein projects, revision guides to help refresh student memory, quizzes and disease fact files, and links to various campaigns, such as Global Handwashing Day and EAAD. In June 2010, ECDC funded a workshop for teachers and students to discuss these future web site developments. These will be finalized and posted on the web site in English, in 2010, and in the other languages through 2010 and 2011.

For further information about the e-Bug project, please contact Dr Cliodna McNulty (cliodna.mcnulty@hpa.org.uk) or Dr Donna Lecky (donna.lecky@hpa.org.uk).

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