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Assessment of E-Bug Database Assisted Education of Class VII School Children on Antimicrobial Resistance Determinants: a Non-Randomized Education Study In a Cross-Section of Schools Around Manipal Town, Udupi, India

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Abstract

Introduction:
Antimicrobial resistance (AMR) is a recognised public health threat today globally. Though many active and passive stewardship strategies are employed to counter AMR clinically, educating school going children on AMR could be a futuristic cost-effective measure to minimize AMR development. We hypothesised NICE's e-bug module to class VII school students on AMR determinants.

Methodology:
A prospective non-randomized intervention study on 327 students belonging to 9 schools of class VII around Manipal town, Udupi district, Karnataka state, India were included for the study. 10 questions on AMR determinants extracted from NICE's e-bug program were quizzed in written as pre-test followed by an education intervention on the same questions followed by a post-test to end the session. Descriptive statistics to estimate epidemiological characteristics, Wilcoxon Signed Ranks and Kruskal-Wallis tests were applied to analyse statistical significance of pre/post-test performance scores for the 10 questions and between schools respectively

Results:
Students had inadequate knowledge on 7 AMR determinants (antimicrobial indication, its course, hand hygiene, fermentation, spread of infection, microbial multiplication and characteristics of microbe) when analysed for post-test performance ($p<0.05$). Comparison of post-test performance of 9 participating schools revealed statistical significance ($p<0.05$) for 3 questions (definition on antimicrobial, cover while cough/sneezing and microbial characteristics)

Conclusion:
Although students exhibited sub-optimal knowledge on few AMR determinants, they showed keenness to learn exhibited by their performance. Our findings and previous similar studies from Europe are suggestive of early pedagogic interventions on AMR through

inclusion of such education modules in the curriculum could be potential tool for AMR prevention for future generations.

Keywords: Antimicrobial Resistance, stewardship, community, school, students, e-bug, education, pharmacists, India

INTRODUCTION

Antimicrobial Resistance (AMR) is recognized public health hazard worldwide [1]. Policy makers, healthcare workers and other stakeholders have advocated various methods to counter AMR [2] [3].

Studies have associated AMR to inappropriate antimicrobial use encountered across the spectrum of healthcare settings [4]. Clinical antimicrobial stewardship programs (ASP) initiated by expert infectious disease physicians and pharmacists are well recognised by the WHO, ECDC, CDC etc. However there are limited studies on stewardship practices in the community which poses to be an ecological contributor of AMR. Community pharmacists' have been reported to lead ASP thereby containing inappropriate antimicrobial prescribing. [5]

Containing AMR in India

ASP in India is still in nascent stages where policy makers and hospital administrators are creating awareness since Chennai declaration [6] [7]. The Indian primary healthcare scenario shows a skewed patient to physician ratio predominantly in rural areas [8]. This gap is reported to be filled in by allied health professionals like pharmacists and rural medical providers [9] [10]. Educational interventions on health aspects aimed at school going children have been reported to impart healthier lifestyle [3] . Promoting knowledge through hands-on educational programs on antimicrobial use in children is reported to improve awareness about infection prevention which is termed to be crucial in allowing them to take conscious decisions on appropriate antimicrobial use [11] [12]. The National Institute of Clinical Excellence (NICE) and research findings from Europe recommend that schools should teach about prevention of infections, self-care, appropriate antimicrobial use and stressed the need for health interventions in early childhood [13] . We were able to identify one qualitative study on AMR knowledge amongst students and teachers earlier reported from India [14] . With no interventional study earlier reported from India, we hypothesised an educational intervention targeting school children to be a strategy towards AMR prevention for future generations in an Indian sub-population.

Materials and Methods:

A prospective non-randomized intervention study was conducted on class VII school children of select schools around south west of Karnataka state (Manipal Town, Udupi District) India during August 2017 to April 2018. The study was approved by the Institutional Ethics Committee (IEC).

Selection of study participants and criteria: Eligible students from government, private and charitable schools after taking assent from their parents were included for the study (Figure.1). Parents who assented but whose students not available during the education session and those who did not assent were excluded. During the assenting process, one parent enquired about the study telephonically. Few others enquired telephonically seeking specific information, like:

1. Whether we were going to take some injections to the school and inject them to the students?
2. Whether any medications will be given to the students?
3. Whether they have to miss the classes?
4. Do they have to go anywhere outside of the school?

Schools, acknowledged to participate but not given ethical permission by the IEC (due to its scheduled status) were also not included in the study.

Educational Intervention module: The schools were visited twice and entire study was executed during routine school hours. Medium of the written quiz and education was in English and Kannada. Assented children belonged to 5 schools (235 children) participated in English education module while participants from 4 schools (92 children) were from Kannada medium schools who completed in the same language module.

The first visit was to submit the informed consent document and subject information for assenting from the student's parents for participation in the study. During the second visit the education intervention was conducted. The entire education session was designed for 40 minutes duration in the class room provided with a pre-test (10 minutes) followed by an educational intervention (for 20 minutes) and a post-test (10 minutes). The pre-test was based on ten questions from e-bug database for junior grade children with a written quiz on factors contributing to AMR. Medium of instruction was both English and Kannada. The questions covered concepts on microbes, antimicrobials, AMR, hygiene and fermentation process (Figure.2). Pre-test was followed by an education intervention with an interactive session with students on e-bug database questions with hand drawn images on thermocole serving as educational aids and models of common pathogens (eg: sore throat), few non-pathogenic microbes and WHO's hand-washing steps. The study intervention concluded with a post-test quiz with same questionnaire which was used as pre-test.

Statistical Analysis:

Ticked pre and post-test responses during the quiz was manually evaluated. Each response were scored one mark for every right answer and zero for incorrect which was then computed for individual students and later expressed as cumulative percentage scores. Individual student scores were entered first in Microsoft Excel 2010® sheets, and then exported to SPSS Version 20®, IBM Corp, Illinois, USA for further statistical analyses. Each AMR determinant (question) Wilcoxon signed Rank and Kruskal-Wallis tests were applied to analyse pre and post-test responses between students and overall participating schools respectively, p-value of $p<0.05$ was considered statistically significant.

Results:

Our study covered 9 schools, in which a total of 327 students participated and completed the education session (Table-1). 160 (49%) students were boys and 167 (51%) girls. 4 schools were state government run, 4 were affiliated to private institutions and 1 charitable. Syllabi-wise, 2 were affiliated to central board for secondary education [CBSE], Govt. of India and 7 belonged to state board, Karnataka state. We used NICE's 10 questions published in the e-bug programmed database aimed for AMR education in school children. Students' knowledge for questions (#1, 2, 5, 7, 8, 9 and 10 – were based on definition on antimicrobial, general characteristics of microbe, uses of microbes, spread of infection and personal hygiene respectively) showed statistical significance ($p<0.05$) with our education intervention(Table.2). Comparison of the post-test percentage of the 9 participating schools (Table.3) of all the ten questions: we found question 1, 3 and 10 (definition on antimicrobial, cover while cough/sneezing and on personal hygiene) to show statistical significance ($p<0.05$) suggesting improved awareness.

Discussion:

e-Bug, a pan European antimicrobial and hygiene teaching resource is reported to serve as an educational tool aimed to reinforce awareness to school children and teachers on antimicrobials, hygiene and transmission of infections. (3) [Table.2 and 3]
While testing our hypotheses of education intervention on AMR in school students, we investigated the impact of education on the understanding of antimicrobial indication.
Our study could be considered as an extension of previously reported Indian study among a high school students and teachers from New Delhi which showed sub-optimal antimicrobial knowledge [14]. Regards to taking the course of antimicrobials, post-test responses showed

a statistical significance (p<0.05) suggestive of improved awareness. During intervention, students were taught about completing the therapeutic course of antimicrobials to prevent the infection recurrence. Similar study was reported from Braga, Portugal on completing therapeutic course of antimicrobial. The authors reported inadequate knowledge on timing and duration of antimicrobial therapy from secondary school and university (9th and 12th grades) students through their cross-sectional questionnaire [11]. The orientation on hand washing using WHO's hand washing techniques were showed statistical significance (p<0.001) indicating inadequate knowledge. The question attempted to improve awareness of personal hygiene to keep infections away. Inadequate knowledge was earlier reported from a cross-sectional study among 8 to 9 years old children belonging to an urban school from Mumbai, India using a pre-designed questionnaire on hand hygiene, and hand wash practices [15]. The term bacteria or microbe is invariably understood something harmful or dangerous. We explored the knowledge about the usefulness of non-pathogenic microbes in making bread and yogurt through fermentation. Students were "surprised" to know the uses of microbes indicative in their positive responses (p<0.001). A French study, taking interviews from a small sample of three girls and seven boys after school hours investigated the knowledge on useful microbial effects. Students had difficulty in stating the applications of microbes in the field of biotechnology while some were unfamiliar with its day to day microbial application [16].

Our study findings showed 48.6% of students did not agree that microbes can be picked up from door handles when posed with a question on source of infection which when comparing pre and post test scores showed statistical significance (p<0.001). Microbial contamination of door handles and knobs are well documented vehicles for cross-infections and recontamination of washed hands resulting in spread of infection between persons. A study reported from Nigeria where door handles and knobs of toilets and bathrooms in churches, markets/parks, banks, restaurants and government establishments were identified with bacterial contaminants[17].

We analysed children's knowledge on microbial multiplication showing a statistical significance following the education session (p<0.001) going in line with an earlier study reported in children of 7-14 years of age [18] . They were educated by drawing a diagram of bacterial multiplication on the black board, a picture of how microbes can multiply rapidly. The study was done using microorganism models depicting general characteristics of microbes e.g. size, multiplication, various common infectious diseases and health. Children of different age group possessed different ideas about microbes. It is noteworthy to mention the author concluding that children considered reproduction of microbes to be an aggressive process which according to them were dangerous. The post-test knowledge score on microbes being living organisms and cannot be seen through a naked eye showed a statistical significance (p<0.001) suggesting the need for further education about the importance of microscope to identify them. This corroborates to an earlier interview based findings by M. Gail Jones et.al on 5th, 8th, and 11th-grade students, teachers, and medical professionals using an a pre-designed drawings of morphological characteristics and various types of microorganisms. The study concluded stating students, teachers and medical professionals had different understandings about microbial characteristics. The author's however emphasized the need for education at different levels of academic and professional qualification [19].

The study though executed in accordance with ethical principles we would list three limitations. Firstly, the study involved convenient sampling by recruiting schools from the geographical location adjoining Manipal Town, of Udupi District, where the findings is to be interpreted to this region known for higher educational standards in the country. Secondly, though the investigators did take all possible measures to minimize bias in recruit students and voluntary participation, coercion to participate by school management and parents cannot be ruled out. Thirdly, the study was entirely executed by trained undergraduate pharmacy students, hence study findings could vary and hence the impact using the same model with an infectious disease expert. Lastly, the Kannada (questions) version was translated by the investigators and was not validated by a language expert.

Our findings reiterates earlier studies' findings that educating children during middle to high school on need for awareness on infection, microbes and inculcate scientific interest towards shaping behaviours on appropriate antimicrobial use [20] [21] [22] . Understanding on implications of non-pathogenic and pathogenic bacterial effects like fermentation for curdling milk and need and the need for personal (hand) hygiene education respectively needs to addressed because of their vulnerability. Similar educational module should be advocated and implementation in regular school curriculum promises to be a cost-effective futuristic strategy to counter AMR with continuous regulatory support.

Conclusion:

Knowledge on core components that contribute to AMR was found to be insufficient in middle-school going children where educational intervention was proved to improve awareness. Students showed keen interest in learning concepts of antimicrobial use and microbes and their performance suggests good grasping ability which needs emphasises. A comprehensive AMR education module devised by key stake holders promises to be a novel addition to the currently practiced antimicrobial stewardship program education model to target community ecology. Advocating such a model by recognised global institutions like the WHO, US's Center for Disease control, NICE, professional bodies across Europe, and competent agencies across nations could necessitate ease of funding and acceptance for program implementation.

Ethical approval: Institution Ethics Committee, Kastuba Hospital, Manipal approved this study [ref no. KH IEC: 676/2017].

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Tables:

Table 1: Descriptive of students and school demographic data

Description		**N**	**%**
Total Schools (9)	School 1 students	87	26.6
	School 2 students	29	8.9
	School 3 students	14	4.3
	School 4 students	11	3.4
	School 5 students	40	12.2
	School 6 students	47	14.4
	School 7 students	14	4.3
	School 8 students	27	8.3
	School 9 students	58	17.7
Gender (overall)	Male	160	48.9
	Female	167	51.1
School Type	Private	221	67.6
	Govt	81	24.8
	Charitable	25	7.6
School Syllabus	State	251	76.8

	CBSE	76	23.2

Table 2: Comparison of pre and post percentage scores of participating students.

Questions		Correct (%)	Incorrect (%)	p-value@
Q1: Antimicrobials are used to kill bacteria	Pre	85	15	**<0.001***
	Post	93.9	6.1	
Q2: You should always finish your course of antimicrobials	Pre	77.1	22.9	**<0.001***
	Post	93.0	7.0	
Q3: We should always cover our coughs and sneezes	Pre	92.0	8.0	0.869
	Post	92.4	7.6	
Q4: All microbes on our hands are good for us	Pre	92.0	8.0	0.086
	Post	95.1	4.9	
Q5: We should only wash our hands once a day	Pre	92.4	7.6	**0.011***
	Post	96.0	4.0	
Q6: Some microbes can make us ill	Pre	89.3	10.7	0.238
	Post	91.7	8.3	
Q7: We use some microbes to make bread and yogurt	Pre	49.8	50.2	**<0.001***
	Post	84.1	15.9	
Q8: You can pick-up microbes from door handles	Pre	51.4	48.6	**<0.001***
	Post	75.2	24.8	
Q9: Microbes can multiply very fast	Pre	84.1	15.9	**<0.001***
	Post	95.1	4.9	
Q10: If you cannot see a microbe, it is not there.	Pre	70.6	29.4	**<0.001***
	Post	84.0	15.0	

@Wilcoxon Signed Ranks Test was applied to compute pre and post-test percentage scores, p<0.05 was considered statistical significant.
***Questions that was found statistical significant**

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Table 3: Post-test percentage (Correct) responses of participating schools

Post Questions	**% (Correct)**	**p-value ***
Q1	93.9	**<0.001#**
Q2	93.0	0.248
Q3	92.4	**<0.001#**
Q4	95.1	0.223
Q5	96.0	0.114
Q6	91.7	0.692
Q7	84.1	0.057
Q8	75.2	0.191
Q9	95.1	0.243
Q10	84.0	**0.002#**

***Kruskal-Wallis Test was applied to compare post percentage response where p<0.05 was considered significant.**
 # Post-test responses for questions that showed statistical significance

Figure 1: Overview of study methodology

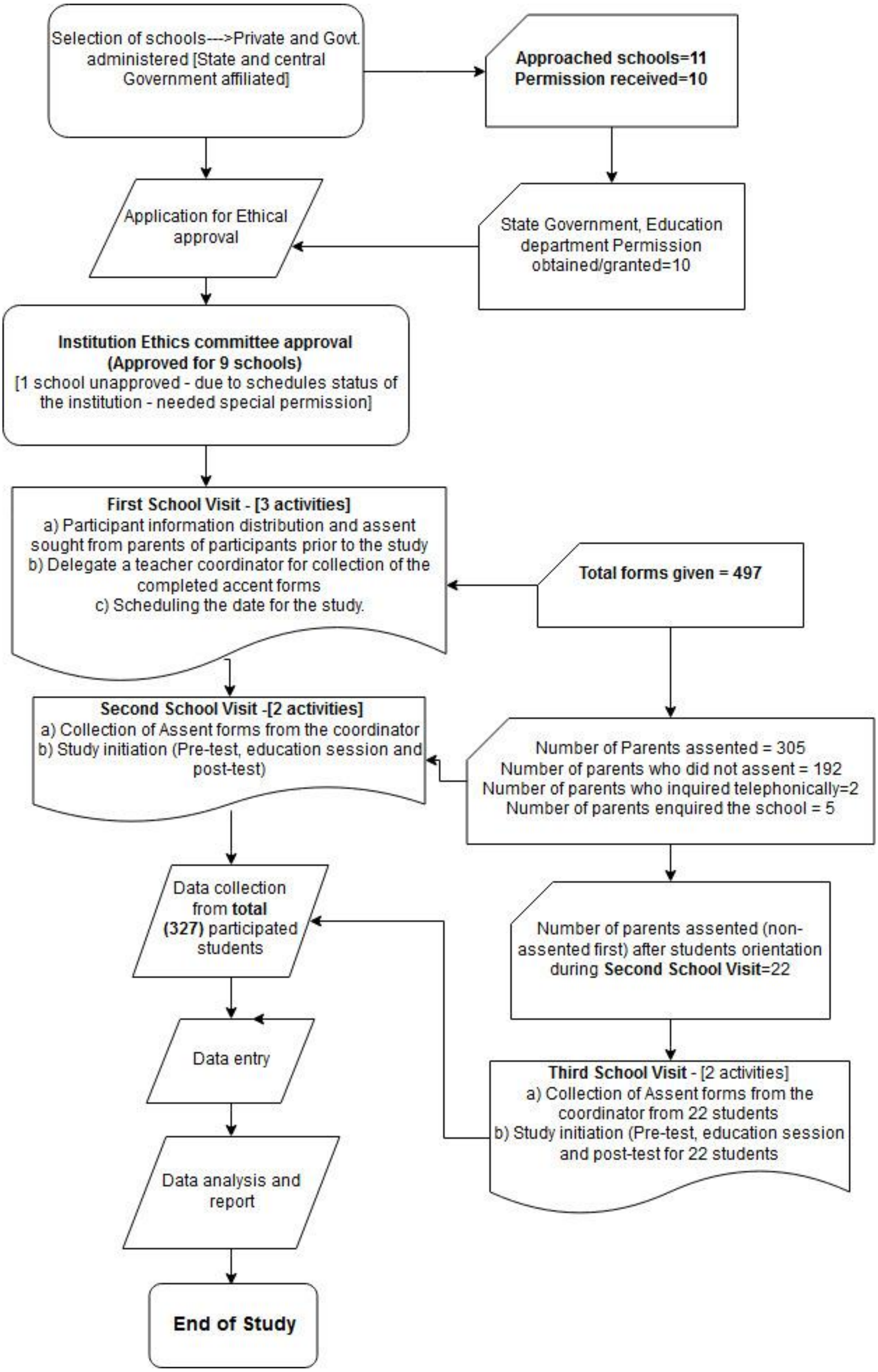
Selection of schools--->Private and Govt. administered [State and central Government affiliated]
Approached schools=11
Permission received=10
Application for Ethical approval
State Government, Education department Permission obtained/granted=10
Institution Ethics committee approval (Approved for 9 schools)
[1 school unapproved - due to schedules status of the institution - needed special permission]
First School Visit - [3 activities]
a) Participant information distribution and assent sought from parents of participants prior to the study
b) Delegate a teacher coordinator for collection of the completed accent forms
c) Scheduling the date for the study.
Total forms given = 497
Second School Visit -[2 activities]
a) Collection of Assent forms from the coordinator
b) Study initiation (Pre-test, education session and post-test)
Number of Parents assented = 305
Number of parents who did not assent = 192
Number of parents who inquired telephonically=2
Number of parents enquired the school = 5
Data collection from total (327) participated students
Number of parents assented (non-assented first) after students orientation during Second School Visit=22
Data entry
Third School Visit - [2 activities]
a) Collection of Assent forms from the coordinator from 22 students
b) Study initiation (Pre-test, education session and post-test for 22 students
Data analysis and report
End of Study

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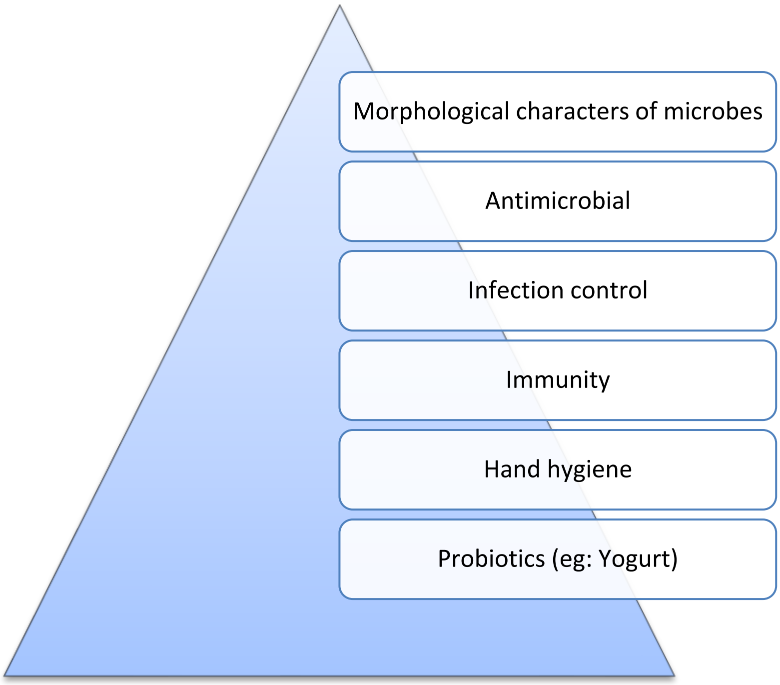
Figure 2: Topics covered during educational intervention



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