Engaging pharmacy personnel in antimicrobial stewardship using a novel method of teaching

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Abstract

Background: Pharmacists need to become antimicrobial stewards to ensure the responsible use of antibiotics. Advanced training in infectious diseases is not offered in South Africa's pharmacy education system. The purpose of this study was to develop an antimicrobial stewardship (AMS) educational tool to engage pharmacists in AMS and improve their infectious disease knowledge. The primary outcome was the identification of a change in infectious disease knowledge.

Method: This was a single-centre study. One pharmacist participated in a “train the trainer” AMS programme with infectious diseases pharmacists in the USA. An AMS comic book was developed to teach basic infectious disease principles to non-infectious disease pharmacists, interns and support staff. The book covered relevant topics, such as why AMS is important, the classification of organisms, organism-antibiotic matching, the antibiotic spectrum and clinical tips. Ten pharmacy personnel, i.e. five pharmacists, two pharmacist interns and three post-basic pharmacist’s assistants, participated. Learning outcomes were measured using pre- and post testing. Study participants took the pre-test, attended a workshop where the AMS comic book was used to aid instruction, and completed a post test and survey. Statistical analysis was performed using the Wilcoxon rank-sum test.

Results: Infectious disease knowledge significantly improved based on pre- and post-test scores (66% vs. 96%) (p-value < 0.05). It was shown in a survey that probed satisfaction levels that 100% of the participants responded favourably to this method of learning.

Conclusion: The AMS comic book proved to be an effective educational tool for non-infectious disease pharmacists, pharmacist interns and pharmacist’s assistants in learning AMS principles. Novel educational methods should be explored to engage pharmacists in this important role.

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Introduction

Decades of overuse and the misuse of antibiotics have led to a post-antibiotic era in which relatively few new antibiotics are being discovered. There is an urgent need to develop multidisciplinary antimicrobial stewardship (AMS) programmes in hospitals with the emergence of multidrug-resistant organisms. The World Health Organization (WHO) issued a statement acknowledging antimicrobial resistance as a severe threat to global health, which could undermine decades of progress in combating infectious disease.1 The WHO has recommended, through its global action plan on antimicrobial resistance, that nations need to implement AMS across their healthcare systems, and that the international community should assist and support such programmes.1

Antimicrobial stewardship is defined as an activity which promotes the appropriate selection of antibiotics, at an appropriate dose, route and duration of antimicrobial therapy.2 Mendelson et al published an article in 2012 entitled Wake up South Africa! The antibiotic “horse” has bolted, in which they warned that owing to poor antibiotic prescribing habits and lack of regard for infection protection and control (IPC), South Africa is on the brink of encountering untreatable bacterial infections. The authors suggested the need to strengthen rational antibiotic prescribing with strong AMS and IPC programmes.3

An ideal AMS programme comprises a multidisciplinary team of an infectious disease physician, clinical pharmacist, infection preventionist and microbiologist. However, many hospitals in the South African setting lack these resources. Physician leader support and a pharmacist to lead the AMS programme is essential.
An advanced level of training in infectious diseases is not offered in the current pharmacy education system in South Africa. However, a small number of pharmacists work in both private and public sector hospitals as antimicrobial stewards. Typical activities include providing advice on the rational use and dosing of antimicrobial agents and writing antimicrobial guidelines. These pharmacists have developed clinical pharmacy skills through ward rounds, continuing medical education on infectious diseases and antibiotics, and by attending lectures and conferences.

One clinical pharmacist provided stewardship, in addition to general dispensing duties, at a private sector Netcare hospital in 2012 at the onset of the antimicrobial stewardship programme. Pharmacists with less experience were reluctant to get involved with stewardship activities at the hospital. The clinical pharmacist tried several attempts to use traditional methods of teaching, with limited success and engagement. It is recognised that pharmacists need to be engaged in AMS in order for there to be a sustainable programme. The purpose of this study was to develop an AMS educational tool that would engage pharmacists and pharmacy support personnel in AMS, and improve their knowledge of infectious diseases. Measuring the change in pharmacists’ and pharmacy support personnel’s knowledge of infectious disease, and identifying any shift in their attitudes towards AMS, was the primary outcome of the study.

**Method**

The research took place in a 295-bed private hospital belonging to the Netcare group. The hospital has a 25-bed intensive care unit (ICU), 14-bed high care unit and 14-bed neonatal unit, as well as medical, surgical, maternity and oncology wards. The pharmacy department employs six pharmacists, two pharmacist interns and five pharmacist’s assistants. The research was approved by the hospital management and the Netcare research review committee.

The AMS pharmacist from the Netcare hospital participated in a “train the trainer” mentoring programme with infectious disease pharmacists from Ohio State University Wexner Medical Center in the USA in November 2013. It was necessary to develop an educational tool to teach general infectious disease and AMS concepts to non-infectious disease pharmacists at the Netcare hospital.

The educational tool needed to be sustainable in a country with limited resources. Under the guidance of the infectious disease pharmacist mentor at Ohio State University, a comic book application (app) was used to develop a book titled *South Africa, the antibiotic horse has bolted: a guide to antimicrobial stewardship*, with the permission of the authors of the original article. The Comic Life app was downloaded from the Apple app store to an iPad and desktop computer for a 30-day free trial period. The Comic Life app is easy to use, and allows for the creation of graphics and images. The app was used successfully by a former Ohio State University infectious disease pharmacist, who created a comic book to teach basic infectious disease concepts and AMS to non-infectious disease pharmacists, residents and students at Ohio State University. This comic book is printed by the medical centre at the university and is used for teaching purposes in its AMS programme. The content of the book used in this study incorporated antibiotic data specific to the Netcare private hospital. Open-source, free cartoon images downloaded from the Internet were used to design each page. Eight pages were designed, six in comic book format, while available antimicrobial agents at the Netcare private hospital were listed over two pages. The comic book took one week to design.

**Contents of the comic book**

The contents of the comic book were as follows:

- **Page 1**: Cover
- **Page 2**: Why AMS is important
- **Page 3**: Classification of organisms
- **Page 4**: Gram-positive organisms, including Staphylococcus, Enterococcus and Streptococcus spp. and the antibiotics used to treat them
- **Page 5**: Gram-negative organisms, including Pseudomonas and Klebsiella spp. and the antibiotics used to treat them
- **Page 6**: Anaerobic and atypical organisms
- **Pages 7-8**: Available antibiotics and antifungal agents in South Africa, their route of administration and spectrum of activity.

The comic book app was then used for an AMS education session at the Netcare hospital, and the impact of the educational tool on infectious disease knowledge was evaluated using a pre- and post-test. The test questions were developed under the guidance of the
Ohio State University infectious disease pharmacy mentor, and covered AMS principles, together with the antibiotic spectrum of activity, organism identification, organism-antibiotic knowledge and clinical tips. The test consisted of five different infectious case study questions using a multiple-choice format.

The pre-test was administered while the investigator was at the Ohio State University mentoring programme in the USA. The test was sent electronically to the pharmacy manager at the Netcare hospital. The participants were instructed to take the test without any preparation. The answers were returned to the investigator electronically.

**Pre-test questions**

1. Which of the following are important reasons for pharmacists to participate in antimicrobial stewardship?
   a. It decreases antimicrobial resistance  
   b. It has an impact on escalating antimicrobial costs  
   c. It improves patient outcomes  
   d. It assures appropriate antimicrobial use  
   e. It preserves antibiotics for the future.
   i. a, b and c  
   ii. a, c and d  
   iii. b, d and e  
   iv. All of the above.

2. SK, a 59-year-old man, is admitted to the ICU with necrotising fasciitis. The doctor calls you to recommend an antibiotic to treat what is suspected to be methicillin-resistant *Staphylococcus aureus* (MRSA). Which of the following antibiotics cover MRSA?
   a. Vancomycin  
   b. Cloxacillin  
   c. Tigecycline  
   d. Cefazolin  
   e. Linezolid.
   i. a, b and c  
   ii. a, c and e  
   iii. c, d and e  
   iv. All of the above.

3. ML, a 43-year-old woman, is admitted to the surgical ICU after a laparotomy for an ischaemic bowel. On postoperative day 4, she develops a fever of 39.5 °C and a white cell blood count (WBC) of 25 000 cells/mm³. The blood culture is positive for a Gram-negative organism. Which organism(s) is (are) not consistent with the result of the blood culture?
   a. Methicillin-sensitive *S. aureus*  
   b. *K. pneumoniae*  
   c. *P. aeruginosa*  
   d. *Clostridium difficile*  
   e. *Acinetobacter baumannii*.
   i. b and c  
   ii. b, c and e  
   iii. a and d  
   iv. All of the above.

4. TR, a 35-year-old poorly controlled diabetic, is admitted to the general medical ward for diabetic ketoacidosis and pneumonia. A sputum culture is obtained upon admission, in which extended-spectrum beta lactamase-producing (ESBL) *K. pneumoniae* is growing. Which antibiotic would you recommend to treat TR’s pneumonia?
   a. Piperacillin and tazobactam  
   b. Cefepime  
   c. Ertapenem  
   d. Vancomycin  
   e. None of the above.
   i. a  
   ii. b  
   iii. c  
   iv. e.

5. ES, a 75-year-old man, is admitted to the surgery ward. He has end-stage renal disease and receives peritoneal dialysis. He presents with severe abdominal pain and an elevated WBC count. The doctor calls you as she suspects peritonitis, and wants a recommendation to treat anaerobes. Which of the following antibiotics has anaerobic activity?
   a. Metronidazole  
   b. Piperacillin/tazobactam  
   c. Ciprofloxacin  
   d. Meropenem  
   e. Amoxicillin/clavulanate.
   i. a, b and c  
   ii. a, d and e  
   iii. a, b, d ane e  
   iv. All of the above.

After completing the two-week Ohio State University train-the-trainer programme, the investigator returned to South Africa. The educational comic book, *South Africa, the antibiotic horse has bolted: a guide to antimicrobial stewardship*, was then used for a 30-minute educational session, in conjunction with the comic book. Immediately thereafter, the post test was administered, in addition to a satisfaction survey. The post test contained the identical questions used in the pre-test. An additional four questions were included in the survey on satisfaction, in which participants were asked to evaluate this new method of learning.

The four questions in the survey on satisfaction were:
- Was the pre-test hard?  
- Was it easy to learn using the comic book?  
- Did you learn new information?  
- Was this an enjoyable learning method?

Survey answers options were either “Yes” or “No”.

Ten pharmacy personnel, i.e. five pharmacists, two pharmacist interns and three pharmacist’s assistants, participated in the study. This equates to 77% of the total pharmacy personnel employed at the hospital. All 10 participants were women, with a median age of 34 years. The pharmacist interns and pharmacist’s assistants were trained to collect data in AMS, which were then brought to the
attention of the pharmacist.

Test scores are reported as a median (interquartile range) per study group. The Wilcoxon rank-sum test was used to determine statistical differences between the pre- and post-test groups. P-value < 0.050 was considered to be statistically significant. Analysis was performed using Stata® version 11.

**Results**

Participants completed the pre- and post test. Each test took 15 minutes. Overall infectious disease knowledge of AMS significantly improved, based on the pre- and post-test scores (66% vs. 96%) (p-value < 0.050) (Figure 1). These figures were calculated as the average of the pre- and post-test scores. It was shown in the survey on satisfaction that 100% of the study participants responded favourably to this method of learning. All 10 personnel responded “Yes” to the four questions in the survey on satisfaction. This equates to a 100% response rate.

The largest percentage change pertained to questions 4 and 5. Question 4 asked about the antibiotic drug of choice for ESBL-producing *K. pneumoniae* (with scores of 40% and 100%, for the pre- and post-tests, respectively). Question 5 asked participants to identify antibiotics with anaerobic coverage (with scores of 40% and 100%, for the pre- and post-tests, respectively).

**Discussion**

The AMS comic book proved to be an effective AMS educational tool, and an innovative way of learning AMS principles and appropriate antimicrobial prescribing for non-infectious disease pharmacists, interns and assistants. The content of the comic book aimed to convey the essential elements of basic stewardship principles. This resulted in a significant increase (p-value < 0.050) in the study participants’ knowledge of AMS, thus increasing the pharmacists’ confidence as they started to work with the essential basic elements of AMS. All of the participants in this study voted in favour of using the comic book to learn the principles of AMS and the application thereof.

The largest change in knowledge related to the test questions on appropriate antibiotic therapy for the treatment of ESBL-producing *K. pneumoniae* and anaerobic infections. Brink et al. first reported on the emergence of ESBL-producing *K. pneumoniae* in South Africa in 2007.5 The study participants varied in age and received their pharmacy training at different times, some prior to 2007. It is probable that they did not receive instruction on the appropriate antibiotic therapy for ESBL-producing bacteria. Thus, some of the participants were unable to answer the question correctly initially. The AMS comic book lists the drug of choice for infections due to ESBL-producing *K. pneumoniae*. Thus, the participants could answer the post-test question correctly.

The second question that revealed a knowledge deficit related to double anaerobic coverage. This was identified by the study investigator as an ongoing problem at the study site. Previous educational efforts by the investigator addressed the issue of double anaerobic coverage using a traditional lecture style format. However, the gap in the knowledge remained. Again, the AMS comic book specifically addresses this issue, and all of the study participants answered the post-test question correctly.

A literature search on novel ways of teaching stewardship to non-infectious disease-trained pharmacists revealed that such programmes are unavailable, and that work has not been carried out in this area. Comic book education is utilised by the medical fraternity. A group of medical artists and physicians explored the interaction between the medium of comics and health care. The authors state that sharing information via comics affords good doctor-patient communication, which increases patient satisfaction.6 The Comic Life® app was easy to use and facilitated the creation of visual documents. It also provided a novel method of teaching AMS to pharmacists, and proved to be a fun and innovative way to learn.

The confidence and knowledge gained by the investigator from the Ohio State University train-the-trainer programme helped to successfully engage pharmacy colleagues in AMS. This enabled the AMS programme to be extended throughout the whole hospital. Each study participant is equipped with the knowledge to handle basic AMS concepts, and has the ongoing support of both the clinical pharmacist, who completed the Ohio State University train-the-trainer session, and the Ohio State University infectious disease pharmacist mentor. The mentor returns to the study site annually to meet with the AMS team and to assess its progress. The WHO recommends that nations implement AMS across their healthcare systems, and in its global action plan on antimicrobial resistance requests that the international community should assist and support such programmes.7 This study met these recommendations.

Based on this preferred method of learning, the comic book education format was subsequently used to teach appropriate
antibiotic use for surgical prophylaxis, as well as patient medication information on discharge. The role of the pharmacist in this hospital has also been extended so that pharmacists now service dedicated wards and are responsible for AMS interventions in their wards.

**Conclusion**

Although the study was small, the results suggest that it would be useful to extend the use of the comic to other hospital pharmacists.

Pharmacists need a basic working knowledge of AMS. Novel educational methods, such as the comic book used in this study, should be explored in order to engage pharmacists in this important role. Pharmacists have an obligation to participate in AMS programmes and contribute to society to ensure the effective use of antimicrobial agents in the long term, and to prevent the spread of multi-resistant organisms.

**Conflict of interest**

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them when writing this paper.

**Declaration**

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**Suid-Afrikaanse Noodhulpliga**

**Noodhulp stap vir stap**

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