



Department of Production Animal Studies and Department of Paraclinical Sciences, Faculty of Veterinary Science, Onderstepoort 0110, South Africa.

Note: This is Online Appendix 1 of Smith, P.W., Agbaje, M., LeRoux-Pullen, L., Van Dyk, D., Debusho, L.K., Shittu, A. et al., 2019, ‘Implication of the knowledge and perceptions of veterinary students of antimicrobial resistance for future prescription of antimicrobials in animal health, South Africa’, *Journal of the South African Veterinary Association* 90(0), a1765. <https://doi.org/10.4102/jsava.v90i0.1765>

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Online Appendix 1

INTRODUCTION: This education research survey will take an average of 60 min to complete. It is expected that each student will attempt all questions independently. The outcomes will be freely disseminated to all participating institutions and will be made freely available online afterwards.

AIM:

- The aim of this survey is to determine knowledge gaps in veterinary antimicrobial education in Africa through the assessment of antimicrobial knowledge, attitude and perceptions (KAP) of pre-final and final year veterinary students across the continent.
- The survey will also aim to improve students' stewardship through reinforced learning on antimicrobials in order to help reduce the burden of antimicrobial resistance in the future.
- We ultimately aim to identify areas of veterinary antimicrobial education that needs improvement, create an interactive learning site with links to other useful sites and improve the curricula in African veterinary schools.

PRIVACY AND CONSENT:

- While personal information required from participants is kept to the minimum and only for coding purposes, the information will not be used for any other purpose than for this research and no personal identifier will be linked to any student. Taking part in this survey is completely voluntary. The privacy of each participant will be respected.
- A refusal to participate in the survey will not in any way bias opinion against the student nor affect the student's grades.
- **Completing this questionnaire will indicate your consent that the information provided can be used as part of this research project and for publication purposes.**

RULES:

- Kindly take the survey only once and complete all the questions. No individual grade will be allocated.
- Please complete the questionnaire honestly WITHOUT consulting external sources or references.

REWARDS

- Participants who completed all the questions will receive a **Certificate of Participation** that will be mail to you through your institution.
- Participants will be part of an innovative contribution to One Health and in establishing an important guide for antimicrobial education and usage to future veterinarians.

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Thank you for your participation!

Knowledge, attitude and perception of veterinary students in Africa on antimicrobial administration in intensive animal production

Section 1: General

University: Class: Pre-final Final
 Gender: Female Male
 Age:

Section 2: Proposed area(s) of specialisation post-graduation. Mark with



| | |
|---|--|
| <input type="radio"/> Small animal practice | <input type="radio"/> Beef cattle |
| <input type="radio"/> Equine practice | <input type="radio"/> Sheep and goat |
| <input type="radio"/> Mixed practice | <input type="radio"/> Pig |
| <input type="radio"/> Feedlot | <input type="radio"/> Poultry |
| <input type="radio"/> Dairy | <input type="radio"/> Laboratory medicine/Clinical pathology |
| <input type="radio"/> Wildlife | <input type="radio"/> Exotic pet medicine |
| <input type="radio"/> Gross Pathology | <input type="radio"/> Education |
| <input type="radio"/> Pharmaceutical industry | <input type="radio"/> Undecided |
| <input type="radio"/> State service | <input type="radio"/> Others (_____) |

Section 3: Previous knowledge

Have you had any experience (clinical, research or pharmacology education) in using antimicrobials before entering the veterinary school?

Yes No

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Please complete the following questions (sections 4 and below) with specific regard to the preceding enquiry by placing a CROSS in the appropriate box.

Section 4: Perceptions of antimicrobial use and resistance

| Mark your answer with X | | <input checked="" type="checkbox"/> | | | | |
|-------------------------|---|-------------------------------------|--------------------------|----------------------------|--------------------------|--------------------------|
| | | strongly agree | agree | uncertain/not sure/neutral | disagree | strongly disagree |
| 1. | Antimicrobial resistance is an increasing global threat to human and animal health | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. | The misuse of antimicrobials by veterinary practitioners contributes significantly to antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. | The misuse of antimicrobials by farmers contributes significantly to antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. | The inappropriate use of antimicrobials in food-producing animals significantly contributes to antimicrobial resistance in human pathogens | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. | The inappropriate prescription of antimicrobials by human medical doctors is the main contributor to antimicrobial resistance in human pathogens | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. | I have received formal lectures on the rational use of antimicrobials during my under-graduate training | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. | My under-graduate training has prepared me well for making informed decisions when choosing an ideal antimicrobial for an individual patient | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. | As an individual in practice I can significantly contribute to preventing an increase in antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. | The misuse of antimicrobials was evident in the facilities where I have trained | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. | Governing bodies in Africa are doing enough to help prevent a rise in antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. | Educating lay people on the importance of antimicrobials as controlled scheduled compounds will have a positive effect on decreasing the rise in antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

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| | | strongly agree | agree | uncertain/not sure/neutral | disagree | strongly disagree |
|-----|--|--------------------------|--------------------------|----------------------------|--------------------------|--------------------------|
| 12. | The use of antimicrobials in the food-producing industry (farm animals) contributes more to antimicrobials resistance than their use in companion animals | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. | Banning the use of prophylactic antimicrobials in food-producing animals will have a negative effect on animal welfare | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. | Banning the use of prophylactic antimicrobials in food-producing animals will have a positive effect on decreasing the rise in antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. | Banning the use of antimicrobials as growth promoters in food-producing animals will have a positive effect on decreasing the rise in antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. | Improved use of vaccines, biosecurity measures and hygiene will decrease the need for antimicrobials in the food-producing industry | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. | Adhering to meat and milk withdrawal periods will help decrease the rise in antimicrobial resistance in human pathogens | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. | Broad-spectrum antimicrobials are ideal to use as first-line antimicrobials | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 19. | Third and fourth generation antimicrobials should only be used as a last resort in treatment | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 20. | Long-acting antimicrobials are more ideal for use in food-producing animals than shorter-acting equivalents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 21. | Cultures and antibiotic sensitivity testing e.g. antibiograms should be done as frequently as possible to guide antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 22. | Financial constraints of animal owners in Africa disallow the use of cultures and antibiotic sensitivity testing e.g. antibiograms during an infection | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 23. | Drug legislation in Africa is on par with legislation in the rest of the world | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 24. | I am confident that new classes of antimicrobials will be available in the near future to solve current resistance problems | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 25. | The choice of an antimicrobial(s) by a veterinarian should largely be determined based on the cost implications to the farmers | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 26. | I am confident in my ability to choose the ideal antimicrobial agents for a specific patient/group of animals in order to ensure optimal efficacy and safety | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

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Section 5: Perceived knowledge of antimicrobials

| a. I am confident with my knowledge of: | | a | b | c | d |
|--|---|--------------------------|--------------------------|--------------------------|--------------------------|
| b. I am unsure of my knowledge of: | | | | | |
| c. I have a vague idea of the concept of: | | | | | |
| d. I have no idea of the concept of: | | | | | |
| 1. | Spectrum, effect, distribution, indications, side effects and contra-indications of the most commonly used antimicrobial classes in veterinary medicine, as well as the implication thereof | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. | The difference between time-dependant and concentration-dependant antimicrobials | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. | Resistance mechanisms | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. | Making a Gram-stain | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. | Interpreting antibiograms | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. | Finding reliable sources of information to guide empirical use of antimicrobials | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. | Choosing the most ideal route for administering a specific antimicrobial | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. | Choosing the desired time-frame for (duration of) therapy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. | How to go about choosing an alternative if my first choice of antimicrobial therapy failed | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. | How to design an integrated treatment protocol for a specific animal with an infection which includes supportive therapy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

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Section 6: Specific antimicrobial knowledge

Antimicrobial classes

1. In your view, which of the following classes of antimicrobials are the most abused in veterinary medicine? Give a score of 1–11, with 1 being the most abused and 11 being the least abused.

- | | | | |
|--|-------|-------------------------|-------|
| a. Aminoglycosides | _____ | f. Polypeptides | _____ |
| b. Amphenicols | _____ | g. Quinolones | _____ |
| c. Cephalosporins | _____ | h. Sulphonamides | _____ |
| d. Macrolides, lincosamides, ketolides, pleuromutilins | _____ | i. Tetracyclines | _____ |
| e. Penicillins | _____ | j. Combined antibiotics | _____ |
| | | k. Others (mention) | _____ |

2. Kindly match column 1 (class) with column 2 (compounds belonging to the class). Indicate your answers in the box provided in front of column 2. For example

| | | |
|-------------|---|---|
| amoxicillin | 1 | ↓ |
|-------------|---|---|

| | | |
|-------------------------|---|--|
| 1. Beta-lactams | ampicillin, amoxicillin, carbenicillin | |
| 2. Penicillins | polymyxins, bacitracin | |
| 3. Cephalosporins | tylosin, tilmicosin, tulathromycin | |
| 4. Tetracyclines | chloramphenicol, thiamphenicol, florfenicol | |
| 5. Aminoglycosides | sulfadiazine, sulfadimethoxine | |
| 6. Macrolides | penicillins, cephalosporins, carbapenems, | |
| 7. Amphenicols | erythromycin, gentamicin, streptomycin | |
| 8. Fluoroquinolones | cephapirin, ceftiofur, cefquinome | |
| 9. Sulphonamides | enrofloxacin, ciprofloxacin, danofloxacin | |
| 10. Peptide antibiotics | chlortetracycline, oxytetracycline, doxycycline | |

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Characteristics of individual antimicrobial agents

Circle the most correct answer e. g. **a**

1. **Which one of the following antimicrobials should not be used in food-producing animals?**

- a. chloramphenicol
- b. chlortetracycline
- c. penicillin G
- d. ceftiofur
- e. tulathromycin

2. **Which one of the following bacteriostatic agents reaches bacteriocidal levels in the lungs?**

- a. Lincosamides
- b. Macrolides
- c. Sulphonamides
- d. Trimethoprim
- e. Amphenicols

3. **Which one of the following antimicrobial agents is not ideal to use for anaerobic bacteria?**

- a. Metronidazole
- b. Chloramphenicol
- c. Enrofloxacin
- d. Lincomycin
- e. Penicillins

4. **Which one of the following antimicrobials would be most ideal to use in an immune-compromised patient?**

- a. gentamycin
- b. doxycycline
- c. lincomycin
- d. florfenicol
- e. erythromycin

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5. **The efficacy of aminoglycosides is mostly dependent on:**
- the magnitude of the total dose
 - the time above MIC
 - slow intravenous administration
 - its large volume of distribution
 - its long elimination half-life
6. **Penicillin is not effective against:**
- Clostridium* spp.
 - Pasteurella* spp.
 - Leptospira* serovars
 - Mycoplasma* spp.
 - Streptococcus* spp.
7. **Penicillin G would likely be less effective in the following scenarios, EXCEPT:**
- early infections
 - Gram negative infections
 - in the presence of beta-lactamase producing bacteria
 - if administered orally for a systemic infection
8. **Which one of the following combinations is synergistic?**
- Procaine penicillin and a potentiated sulphonamides
 - Tulathromycin and lincomycin
 - Ampicillin and amikacin
 - Benzylpenicillin and florfenicol
9. **A loading dose is generally recommended for the following antibacterial agents:**
- Aminoglycosides
 - Sulphonamides
 - Quinolones
 - Cephalosporins
 - Macrolides
10. **Which one of the following antibacterial drugs is not very effective against Gram-negative bacteria?**

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- a. Polymyxin
 - b. Erythromycin
 - c. Metronidazole
 - d. Neomycin
 - e. Gentamicin
11. **Which one of the following antibacterial drugs would be most ideal to use in the presence of pus and exudates?**
- a. Sulphonamides
 - b. Penicillins
 - c. Aminoglycosides
 - d. Fluoroquinolones
12. **The long-acting characteristic of 2-pyrrolidone oxytetracycline is dependent on:**
- a. Blood proteins
 - b. A prolonged post-antibiotic effect
 - c. The route of administration
 - d. Entero-hepatic circulation
 - e. Microsomal enzyme inhibition
13. **Which one of the following drugs does not achieve prolonged antibacterial activity (> than 24 hours)?**
- a. Tilmicosin
 - b. Procaine benzylpenicillins
 - c. Cefovecin
 - d. Doxycycline
14. **Which one of the following antibacterial agents are not time-dependent?**
- a. Cephalosporins
 - b. Tetracyclines
 - c. Nitro-imidazoles
 - d. Amphenicols
 - e. Sulphonamides
15. **Which one of the following statements is not true for beta-lactamase inhibitors?**
- a. They have been developed to conserve the activity and extend the spectrum of β -lactam drugs

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- against β -lactamase-producing microorganisms
- b. Combined with penicillins they ensure effect with lower minimum inhibitory concentrations against β -lactamase-producing microorganisms
- c. Clavulanic acid, sulbactam, and tazobactam are 3 inhibitors available for clinical use
- d. They have little intrinsic antimicrobial impact
- e. Resistance against amoxicillin-clavulanate is regarded as being extremely rare

Section 7: Species-specific scenarios

1. A sow (female pig) not fed a “laxative” pre-lactation diet and now suffering from *Escherichia coli* infections and its consequences post-farrowing (Hypogalactia-dysgalactia) is brought into your practice. Briefly describe how you will manage the condition with particular emphasis on usage of antimicrobials.

2. An argument ensued between two farmers on whether a sow that recently farrowed 16 piglets without any assistance over a three hour period should be given a combination of Penicillin-Streptomycin, Oxytocin and Corticosteroids post farrowing to assist with the ejection of allantoic and amniotic sacs and aid recovery processes. Your opinion as the pig vet was sought. Briefly summarise your professional opinion based on your conviction.

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A free-range egg farmer's veterinary health consultant, who was a specialist poultry veterinarian, has retired. He has recommended that the farmer utilises your expertise as a veterinarian in future.

It soon comes to your notice that the farmer is used to administering a wide range of antibiotics on the recommendation and prescription of his previous veterinarian, as well as on the advice of his poultry feed company. The same disease and production problems recur year after year, despite these metaphylactic and treatment regimens. In your studies you have repeatedly been taught that most health organisations advocate the following: "the withdrawal of all antibiotics given to healthy animals for economic reasons, especially when those antibiotics are also used for people".

The farmer insists on carrying on with these practices and is hesitant to heed your advice that his present use of antimicrobial compounds may even be illegal. He is reluctant to change, although this injudicious use of antibiotics is also, in all probability, not conducive to sustainable farming, and even the health of the consumers of his eggs is jeopardised.

You also soon become aware that many other broiler and egg producing farmers use antibiotics extensively on their farms. Many farmers report that they are concerned about this situation, as there has been much public lobbying against the indiscriminate and uncontrolled feeding of antibiotics to poultry. They would appreciate viable alternatives that will be effective.

What are your thoughts on the following:

3.1. Why have antibiotics been used so extensively for so many years?

3.2. Is it important to urgently reconsider this widespread use of antibiotics, especially on the advice and prescription of registered veterinarians, and, if so, why is it so important?

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3.3 Should antibiotics only be used on sick individual bird within a flock of birds? Explain your answer briefly

3.4. Should antibiotics be made available only on the prescription of a veterinarian, or should all antibiotics be available “over-the counter” (OTC)? Please explain why you think so.

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2. Discuss appropriate treatment and / or metaphylactic approach to poultry flocks, if they are at risk of suffering an outbreak/s of the following infectious diseases due to exposure to disease agents or extremely unfavourable host or environmental conditions.

2.1 Viral diseases to which poultry are susceptible (no detail is required)

2.2 Bacterial diseases (Colisepticaemia, Pasteurellosis, Salmonellosis, Mycoplasmosis)

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Section 8: Use of educational resources

Circle the chosen option(s). e.g.

a

1. Empirical choices for antimicrobial use should be scientific. Indicate which of the following resources you use to get information on a specific antimicrobial agent from (**you can choose more than one if applicable**):
 - a. Veterinary textbooks
 - b. Peer-reviewed scientific journals (open access)
 - c. Lecturers
 - d. Veterinary hospital pharmacist
 - e. Peers (other students)
 - f. Guidelines published by universities
 - g. Guidelines published by governments
 - h. Guidelines published by other professional organisations
 - i. Pharmaceutical representatives/material
 - j. Wikipedia and similar websites
 - k. Experience from similar previous cases
 - l. Others: (indicate) _____

2. Have you heard about any of the sites/organisations below before now? (**you can choose more than one if applicable**)
 - a. Antimicrobials Resistance Learning Site: <http://amrls.cvm.msu.edu/>
 - b. Alliance for the Prudent Use of Antibiotics (APUA): http://www.tufts.edu/med/apua/about_issue/antibiotic_res.shtml
 - c. European Antibiotic Awareness Day (EAAD): <http://ecdc.europa.eu/en/eaad/Pages/Home.aspx>
 - d. Canadian Antimicrobial Resistance Alliance (CARA): <http://www.can-r.com/>
 - e. European Antimicrobial Resistance Surveillance Network (EARS-Net): <http://www.ecdc.europa.eu/en/activities/surveillance/EARS-Net/Pages/index.aspx>
 - f. Joint Programming initiative on Antimicrobial Resistance (JPIAMR): <http://www.jpiamr.eu/>
 - g. REACT: <http://www.reactgroup.org/>
 - h. The Center for Disease Dynamics, Economics and Policy- Global Antibiotic Resistance Partnership CDDEP-GARP: http://www.cddep.org/projects/global_antibiotic_resistance_partnership
 - i. National Antimicrobial Resistance Monitoring System (NARMS): <http://www.fda.gov/animalveterinary/safetyhealth/antimicrobialresistance/nationalantimicrobialresistancemonitoringsystem/default.htm>
 - j. DANMAP: <http://www.danmap.org/Downloads/Reports.aspx>

Completed questionnaire should be returned to antimicrobialsoft@up.ac.za. Kindly indicate clearly your exact Name & Surname in the response line for the purpose of award of the certificate only.



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k. Others: (indicate) _____

4. Are any of them based in your country? **Yes** **No**

5. Are you aware of any Antimicrobial Resistance Interest Groups in your country?

Yes **No**

If yes, mention _____

Please write any further comments below

Thank you for your time

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