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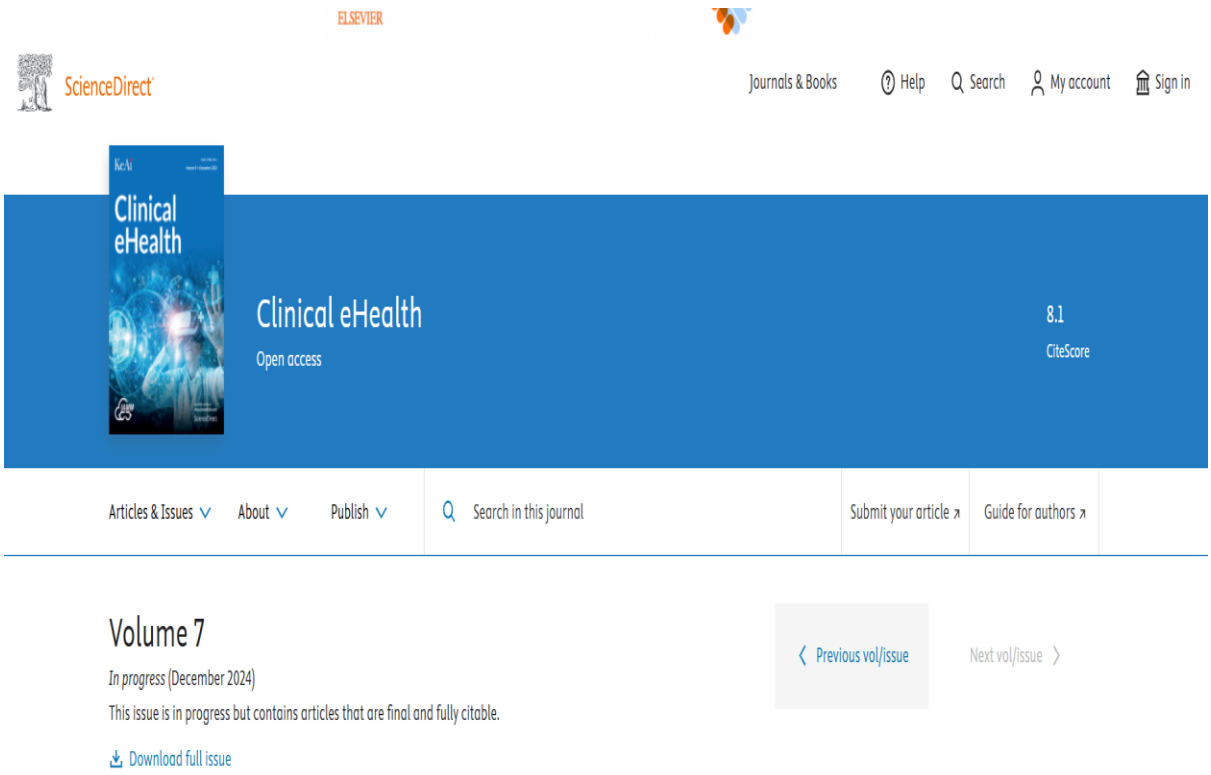

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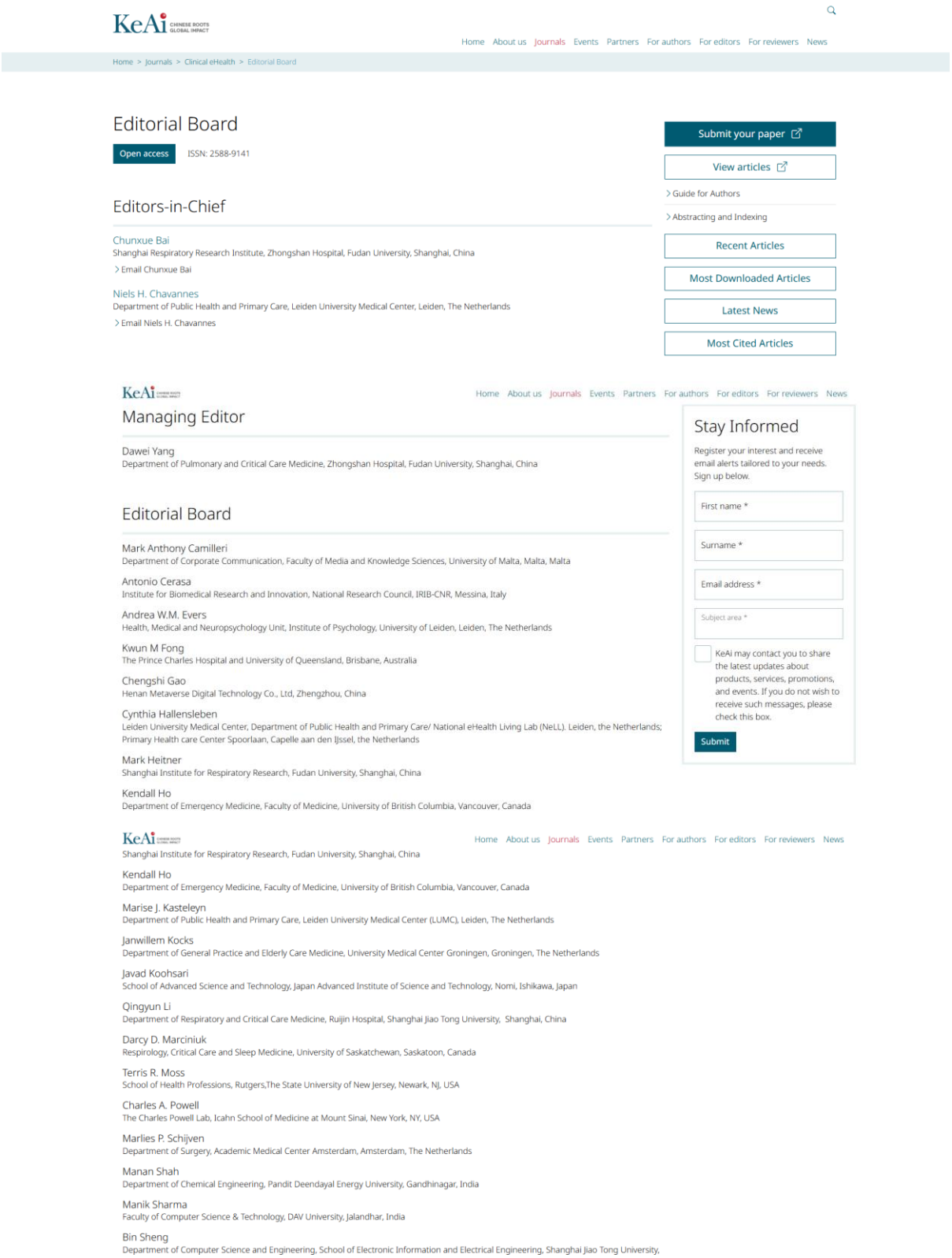

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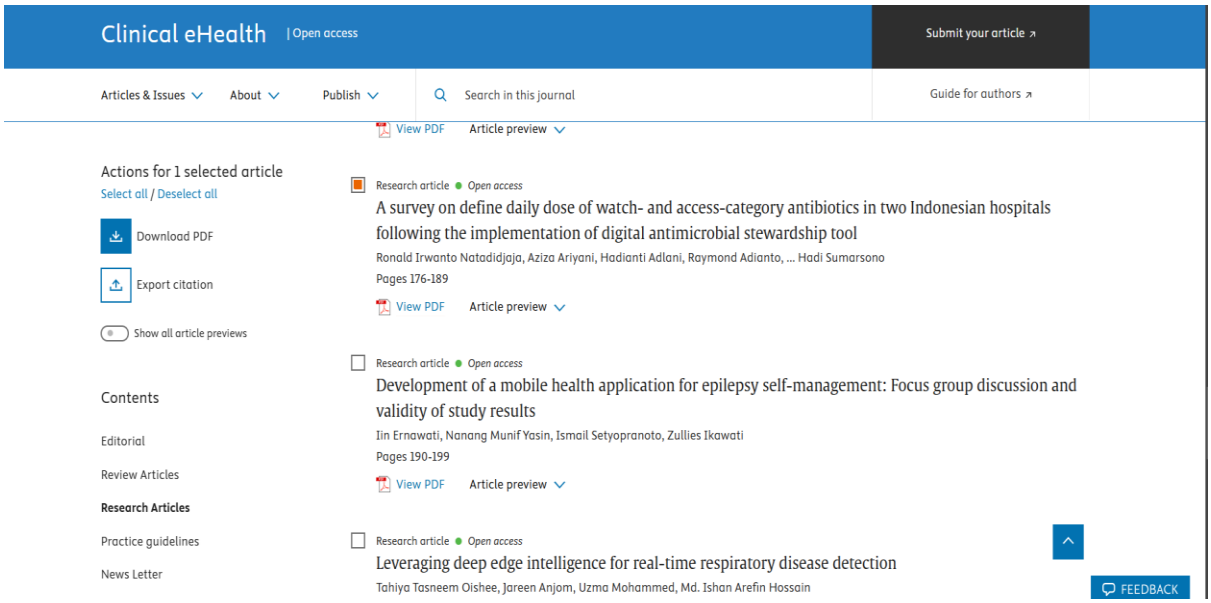

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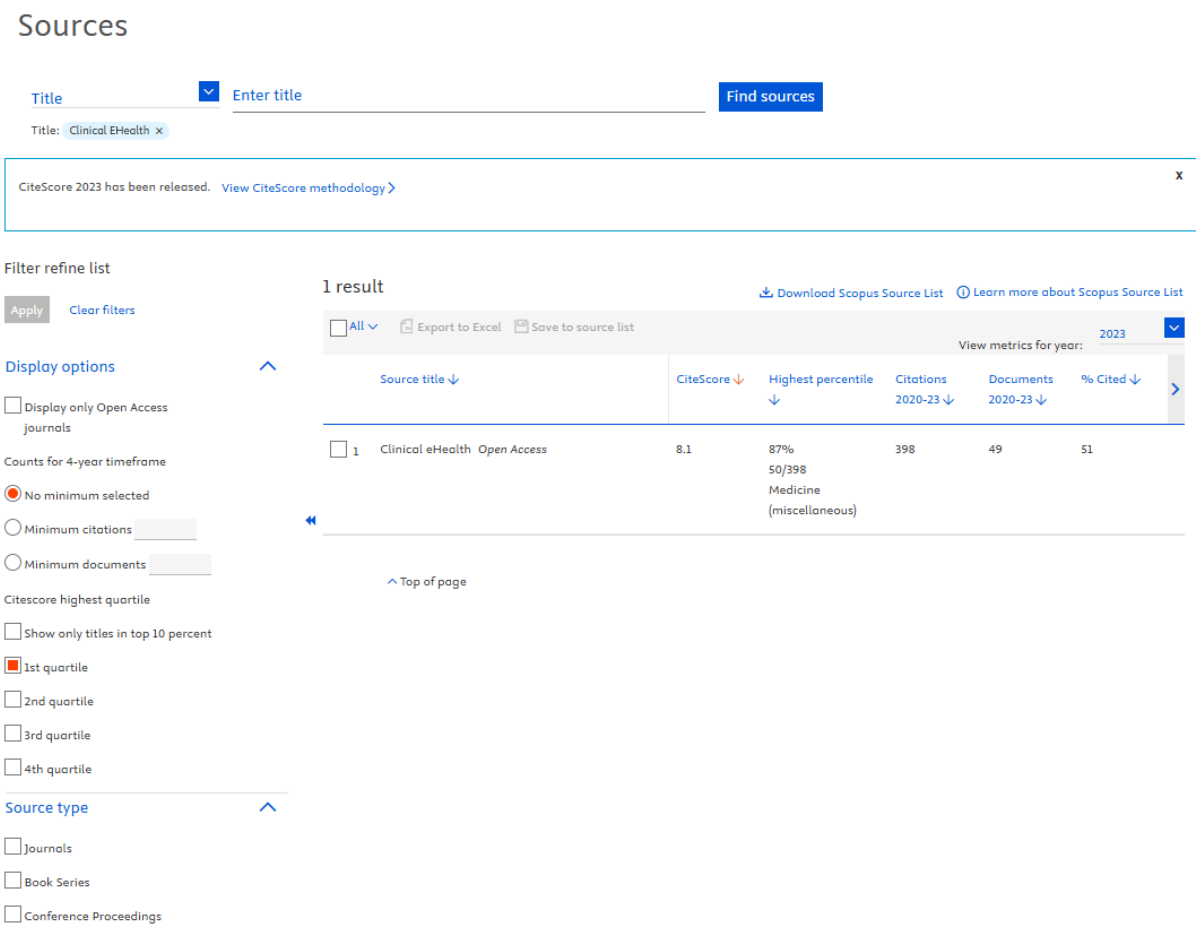

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A Survey on Define Daily Dose of WATCH- and ACCESS-Category Antibiotics in Two Indonesian Hospitals Following the Implementation of Digital Antimicrobial Stewardship Tool

Dear Dr. Natadidjaja,

We have received the above referenced manuscript you submitted to Clinical eHealth.

To track the status of your manuscript, please log in as an author at https://www.editorialmanager.com/ceh/, and navigate to the "Submissions Being Processed" folder.

Thank you for submitting your work to this journal.

Kind regards,
Clinical eHealth

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Manuscript Number: CEH-D-24-00022

A Survey on Define Daily Dose of WATCH- and ACCESS-Category Antibiotics in Two Indonesian Hospitals Following the Implementation of Digital Antimicrobial Stewardship Tool

Dear Dr. Natadidjaja,

Thank you for submitting your manuscript to Clinical eHealth.

I have completed my evaluation of your manuscript. The reviewers recommend reconsideration of your manuscript following minor revision and modification. I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by Dec 06, 2024.

When revising your manuscript, please consider all issues mentioned in the reviewers' comments carefully: please outline every change made in response to their comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

To submit your revised manuscript, please log in as an author at https://www.editorialmanager.com/ceh/, and navigate to the "Submissions Needing Revision" folder under the Author Main Menu.

Clinical eHealth values your contribution and I look forward to receiving your revised manuscript.

Kind regards,

Dawei Yang

Editor-in-Chief

Clinical eHealth

Editor and Reviewer comments:

Reviewer #1: This e-RASPRO tool has a lot of information, but the author only reported few

Clinical eHealth

Editor and Reviewer comments:

Reviewer #1: This e-RASPRO tool has a lot of information, but the author only reported few.
Abstract
The author should add information about the characteristics of the two hospitals. What are their similarities and differences? Why did the author choose these two hospitals among other hospitals?
Aside percentage of cephazolin, the comparison of the number of item of antibiotics, in WATCH and RESERVE category, before and after RASPRO implementation is also important.
How the authors calculate the DDD of antibiotics (the equation)?

Methods
What is the difference of an initial device (blue print) and a full version device?

Results
The author should add the number of patient for every 'Type Risk Stratification' to show the infectious burden (associated with antibiotic use).
Cefazolin is an antibiotic prophylactic. What is the most antibiotic use for empiric or definitive?
How many does the incidence of de-escalation in the hospital?
How many does the prolonged antibiotic administration?
How many does Automatic Stop Order (ASO) perform?
How many does difficult cases?
How the authors calculate this percentage? (There was an increase in DDD of Cephazolin by 167.18%) Cephazolin before e-RASPRO: 7.16, after e-RASPRO: 19.13.
Discussion
In the discussion section, the author should add the implication of decrease or increase antibiotic use. This thought further will come to a recommendation in practice.

Reviewer #2: The authors of A Survey on Define Daily Dose of WATCH- and ACCESS-Category Antibiotics in Two Indonesian Hospitals Following the Implementation of Digital Antimicrobial Stewardship Tool deserve commendation for their insightful and comprehensive work. Their study offers a pioneering look into the practical application of the e-RASPRO digital tool, demonstrating an innovative approach to digital antimicrobial stewardship. By addressing the complex challenge of antibiotic resistance in hospital settings, the authors showcase both a deep understanding of clinical practices and a commitment to advancing the WHO's goals for responsible antibiotic usage.

1. The introduction section lacks major literature and should be extended further.
2. The words "ACCESS, WATCH, and RESERVE" should not be capitalized or if it's necessary, the authors should provide logical reasons for that.
3. What specific criteria were used to select the two hospitals, and how might these selection criteria affect the generalizability of the findings?
4. In Hospital 2, the manual RASPRO system had been previously implemented. How did the study control for the potential impact of this prior system on the results?

Reviewer #2: The authors of A Survey on Define Daily Dose of WATCH- and ACCESS-Category Antibiotics in Two Indonesian Hospitals Following the Implementation of Digital Antimicrobial Stewardship Tool deserve commendation for their insightful and comprehensive work. Their study offers a pioneering look into the practical application of the e-RASPRO digital tool, demonstrating an innovative approach to digital antimicrobial stewardship. By addressing the complex challenge of antibiotic resistance in hospital settings, the authors showcase both a deep understanding of clinical practices and a commitment to advancing the WHO's goals for responsible antibiotic usage.

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3. What specific criteria were used to select the two hospitals, and how might these selection criteria affect the generalizability of the findings?
4. In Hospital 2, the manual RASPRO system had been previously implemented. How did the study control for the potential impact of this prior system on the results?
5. Why was the period of 3 and 9 months chosen for data collection, and how might longer or additional time points affect the study's results?
6. What statistical methods, if any, were used to analyze changes in DDD (Defined Daily Dose), and how could quantitative analysis strengthen the survey's conclusions?
7. Have you used DDD/100 admissions, or DDDs/100 patient days, or DDD/1000 patient days or DOT?
8. I would suggest authors to use the supplementary file to provide information about the "Guideline on Digital Antibiotic Prophylaxis of e-RASPRO tool."
9. The results mention variations in the use of Quinolone and Carbapenem antibiotics between the hospitals. How does the study account for these differences, and what other variables might explain the observed discrepancies?
10. Given the short implementation periods, what evidence suggests that the observed reductions in antibiotic use are sustainable over a longer term?
11. To what extent can the reduction in WATCH-category antibiotics in Hospital 1 be attributed to the e-RASPRO tool versus external factors like hospital policy changes or evolving medical practices?
12. Does the study track patient outcomes related to antibiotic stewardship, such as infection resolution rates, readmissions, or adverse drug reactions? If not, how might these outcomes provide a more comprehensive understanding of e-RASPRO's impact?
13. What specific factors limit the study's ability to establish a cause-and-effect relationship, and how could future studies address these limitations?
14. Why have you measured the use of Reserve type of antibiotics?
15. What strategies would the authors suggest for scaling the e-RASPRO system to other hospitals, particularly those without prior experience in manual RASPRO?
16. How does the study ensure that the reported decreases in antibiotic use do not compromise patient care, especially for high-risk patients in Type III risk stratification?
17. The e-RASPRO tool relies on collaboration across clinicians, pharmacists, and nurses. How does the study address potential challenges in interdisciplinary communication, particularly in urgent situations?
18. What are the potential impacts of integrating the e-RASPRO system with electronic health records, and has the tool been tested for compatibility with existing hospital systems?

Reviewer #3: 1. Is e-RASPRO tool widely used in your country? Is e-RASPRO tool used in any other country?
2. Could you provide the relevant version or software information of e-RASPRO?
3.The screenshot images of the software application interface in the article are not very clear, and the characters inside are basically unreadable, at least in the PDF file I reviewed. I hope it can be improved.

Reviewer #3: 1. Is e-RASPRO tool widely used in your country? Is e-RASPRO tool used in any other country?
2. Could you provide the relevant version or software information of e-RASPRO?
3.The screenshot images of the software application interface in the article are not very clear, and the characters inside are basically unreadable, at least in the PDF file I reviewed. I hope it can be improved.

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Manuscript Number: CEH-D-24-00022R1

A Survey on Define Daily Dose of Watch- and Access-Category Antibiotics in Two Indonesian Hospitals Following the Implementation of Digital Antimicrobial Stewardship Tool

Dear Dr. Natadidjaja,

Thank you for submitting your manuscript to Clinical eHealth.

I am pleased to inform you that your manuscript has been accepted for publication.

My comments, and any reviewer comments, are below.
Your accepted manuscript will now be transferred to our production department. We will create a proof which you will be asked to check, and you will also be asked to complete a number of online forms required for publication. If we need additional information from you during the production process, we will contact you directly.

We appreciate you submitting your manuscript to Clinical eHealth and hope you will consider us again for future submissions.

Kind regards,
Dawei Yang
Editor-in-Chief

Clinical eHealth

Editor and Reviewer comments:

RESPONSE TO REVIEWER'S COMMENT

Reviewer #1: This e-RASPRO tool has a lot of information, but the author only reported few.

Abstract

QUESTION A. The author should add information about the characteristics of the two hospitals. What are their similarities and differences? Why did the author choose these two hospitals among other hospitals?

We add in our abstract and make more details in our method of this manuscript. These two hospital was chosen because they have different status in service Hospital 1, a primary hospital with 134 beds 9 pharmacists, 115 nurses and 37 specialist doctors. Hospital 2, a referral hospital with 254 beds, 39 pharmacists, 368 nurses and 102 specialist doctors. (STATEMENT IS ADDED INTO THE MANUSCRIPT)

Question B. Aside percentage of cephazolin, the comparison of the number of item of antibiotics, in WATCH and RESERVE category, before and after RASPRO implementation is also important.

Yes, thank you sir. Reserve category, in our opinion, also should be targeted, which prescribing must be reduced wisely. This manuscript provide information about shifting prescription from Watch to Access category and reducing numbers of antibiotics before and after e-RASPRO implementation outside cefazolin. In Indonesia the Watch category antibiotics now become big issue, which it maybe the biggest group of antibiotic that's prescribed by clinicians. That is why we concern about this Watch category antibiotics. We hope , in the next day, shifting prescription from Watch to Access category antibiotic can also give the good impact for reducing the Reserve category antibiotics

How the authors calculate the DDD of antibiotics (the equation)?

ATC is a drug classification system that divides drugs into different groups according to their primary action on an organ or organ system, chemical structure, pharmacological and therapeutic properties.
DDD is the assumed average daily maintenance dose for treatment of the primary indication in adults is determined globally for each drug by the WHO Collaborating Center for Drugs Statistics Methodology
The drugs that have DDD are only drugs that already have an ATC code.
Units used for hospitals: DDD/ 100 patient days :
1. Define the data collection period.
2. Collect medical records of patients who are discharged from hospital in that period.
3. Collect data for each patient: Length of stay (LOS), name of antibiotic, dose, duration of use (days)
4. Calculate the DDD for each antibiotic
5. Add up the DDD of all antibiotics used
6. Add up LOS = Total LOS
7. Calculate DDD/100 patient days = $\frac{\text{Total Antibiotic DDD}}{\text{Total LOS}} \times 100$

Each Antibiotic :
DDD / 100 patient days = $\frac{\text{Total Antibiotic Used (gram) / WHO DDD}}{\text{Total LOS}} \times 100$

Authors are not pharmacist and not experts, but the data has been validated by expert pharmacists and hospital management in both hospital

Methods

Question 1 : What is the difference of an initial device (blue print) and a full version device?

Both of them had the same flow, only different on the screen display

(STATEMENT IS ADDED IN MANUSCRIPT)

Results

Question 2 : The author should add the number of patient for every 'Type Risk Stratification' to show the infectious burden (associated with antibiotic use).

We apologise, that we don't have the exact data for each risk stratification when samples were taken, because of our design at the first was only to calculate DDD before-after e-RASPRO implementation meanwhile, currently, the permission for data collection at both hospitals has expired, so we can't get it

Question 3 : Cefazolin is an antibiotic prophylactic. What is the most antibiotic use for empiric or definitive?

In Indonesia, most likely, the high rate of empirical and definitive antibiotic prescriptions for third generation cephalosporins is a national issue, however, we do not have national detailed data regarding this matter.

Question 4 : How many does the incidence of de-escalation in the hospital?

We don't have the exact data for antibiotic de-escalation in both hospitals when samples were taken, because of our design at the first was only to calculate DDD before-after e-RASPRO implementation.

Question 5 : How many does the prolonged antibiotic administration?

We don't have the exact data for prolonged antibiotic administration in both hospitals when samples were taken, because of our design at the first was only to calculate DDD before-after e-RASPRO implementation. However, we hope that the DDD data can be an indicator of overall antibiotic use.

Question 6 : How many does Automatic Stop Order (ASO) perform?

We don't have the exact data for ASO in both hospitals when samples were taken, because of our design at the first was only to calculate DDD before-after e-RASPRO implementation. No data about number of difficult case or automatic STOP ORDER event, both hospitals have not implemented this policy strictly. (STATEMENT IS ADDED INTO THE MANUSCRIPT)

Question 7 : How many does difficult cases?

Because of our design at the first was only to calculate DDD before-after e-RASPRO implementation, we have no exact data about number of difficult case or automatic STOP ORDER event, both hospitals have start this policy, but still not strictly implemented. (STATEMENT IS ADDED INTO THE MANUSCRIPT)

Question 8 : How the authors calculate this percentage? (There was an increase in DDD of Cephazolin by 167.18%) Cephazolin before e-RASPRO: 7.16, after e-RASPRO: 19.13.

We calculate with : ((19.13-7.16) / 7.16)) x100% = 167.17877095 ~ 167.18%

Discussion

Question 9 : In the discussion section, the author should add the implication of decrease or increase antibiotic use. This thought further will come to a recommendation in practice.

When there is a shift in prescription from WATCH to ACCESS category antibiotics and decrease in antibiotic prescribing, hopefully, there will be a decrease in the risk of selective pressure events which will reduce the risk of MDR rising (STATEMENT IS ADDED INTO THE MANUSCRIPT)

Reviewer #2: The authors of A Survey on Define Daily Dose of WATCH- and ACCESS-Category Antibiotics in Two Indonesian Hospitals Following the Implementation of Digital Antimicrobial Stewardship Tool deserve commendation for their insightful and comprehensive work. Their study offers a pioneering look into the practical application of the e-RASPRO digital tool, demonstrating an innovative approach to digital antimicrobial stewardship. By addressing the complex challenge of antibiotic resistance in hospital settings, the authors showcase both a deep understanding of clinical practices and a commitment to advancing the WHO's goals for responsible antibiotic usage.

Question 10. The introduction section lacks major literature and should be extended further.

For the introduction section, the sentences “The access category includes antibiotics that are considered to have a lower potential for resistance compared to the WATCH category” and “While RESERVE category antibiotics are types of antibiotics that are only used if there are suspected infections caused by Multi-Drug Resistant (MDR) pathogens” were taken **from reference no.2**. We also add this to the manuscript. We also add 1 more literature as a rationale of WHO AWARE to build good awareness in the implementation of prudent use of antimicrobial and antimicrobial stewardship (STATEMENT IS ADDED INTO THE MANUSCRIPT)

Question 11. The words "ACCESS, WATCH, and RESERVE" should not be capitalized or if it's necessary, the authors should provide logical reasons for that.

Many thanks for this insight, To write ACCESS, WATCH, RESERVE, we change to normal letters to Access. Watch, Reserve in the manuscript as your suggestion (CHANGE IS ADDED INTO THE MANUSCRIPT)

Question 12. What specific criteria were used to select the two hospitals, and how might these selection criteria affect the generalizability of the findings?

Hospital 1 and Hospital 2 have different settings. Hospital 1 is a primary hospital (not a referral hospital), while hospital 2 is a referral hospital. We will add this information to our manuscript. We wanted to compare the use of e-RASPRO in primary and referral hospitals, therefore we chose these two hospitals (STATEMENT IS ADDED INTO THE MANUSCRIPT)

Question 13. In Hospital 2, the manual RASPRO system had been previously implemented. How did the study control for the potential impact of this prior system on the results?

Due to previous administrative issues, we do not have previous studies on the use of manual RASPRO in hospital 2, so there is no comparison between the use of manual RASPRO and e-RASPRO (digital) in that hospital.

Question 14. Why was the period of 3 and 9 months chosen for data collection, and how might longer or additional time points affect the study's results?

In accordance with the research design that we proposed to the two hospitals at the beginning, we really wanted to see the impact of the difference between a short time and a longer time application of e-RASPRO, therefore we compared 3 months and 9 months of application of this device

Question 15. What statistical methods, if any, were used to analyze changes in DDD (Defined Daily Dose), and how could quantitative analysis strengthen the survey's conclusions?

This survey does not claim a significant relationship between the use of this device and the results obtained. This survey aims only to describe the decline in DDD or maybe changing in the trend of antibiotic use before and after e-RASPRO implementation using simple observational calculations. We believe there are many other factors influencing DDD and antibiotic prescribing in both hospitals that require further research.

Question 16. Have you used DDD/100 admissions, or DDDs/100 patient days, or DDD/1000 patient days or DOT?

We used DDDs/100 patient days. We add this to the manuscript (abstract) : We define DDD as Define Daily Doses/ 100 patients days (DDD) at the abstract section explaining DDD in the next section of this manuscript (STATEMENT IS ADDED IN MANUSCRIPT (ABSTRACT))

Question 17. I would suggest authors to use the supplementary file to provide information about the “Guideline on Digital Antibiotic Prophylaxis of e-RASPRO tool.”

File attached as supplementary file (Item Type: FIGURE).

Question 18. The results mention variations in the use of Quinolone and Carbapenem antibiotics between the hospitals. How does the study account for these differences, and what other variables might explain the observed discrepancies?

The difference in the use of quinolones and carbapenems in this study may still caused by the digital guidance provided to clinicians, but it is also possible that it is related to differences in disease severity from different time periods during which the data was taken in this study. Of course, further research is still needed to see the relationship of the related factors that cause these differences. In this research it cannot be absolutely concluded what factors influence changes in the use of quinolones and carbapenems, because our design at the first was only to calculate DDD before-after e-RASPRO implementation as a preliminary study in e-RASPRO implementation.

Question 19. Given the short implementation periods, what evidence suggests that the observed reductions in antibiotic use are sustainable over a longer term?

In this study we cannot conclude that in the long term, the antibiotic prescribing reduction can definitely be maintained, because there will be many factors that influence this issue. However, through this research we hope that we can give a new insight, as a preliminary study, through digital tools, antimicrobial stewardship can have a good initial impact.

Question 20. To what extent can the reduction in WATCH-category antibiotics in Hospital 1 be attributed to the e-RASPRO tool versus external factors like hospital policy changes or evolving medical practices?

A significant reduction in Watch category antibiotics in hospital 1 did occur in the 9 months before and after using e-RASPRO. However, once again, this research does not cover any factors that definitively influence this event, so it still requires further study and analysis in the future. This research is a preliminary study which is expected to produce further research to improve the effectiveness of using digital tools in carrying out antimicrobial stewardship in Indonesia.

Question 21. Does the study track patient outcomes related to antibiotic stewardship, such as infection resolution rates, readmissions, or adverse drug reactions? If not, how might these outcomes provide a more comprehensive understanding of e-RASPRO's impact?

This study does not include patient outcomes related to antibiotic use. This research only covers the AMU parameter, which is known as one of the global parameters of antimicrobial stewardship. Through this research, it can only be partially concluded that there is a declining event of antibiotics use before and after e-RASPRO implementation, where through this, we hope that there will be an improvement in the achievement of AMU parameters.

Question 22. What specific factors limit the study's ability to establish a cause-and-effect relationship, and how could future studies address these limitations?

Currently we are still faced with various administrative issues such as patient sample collection, human resources, licensing issues and other things. However, we hope that when someday e-RASPRO device is known to give a positive impact on the implementation of antimicrobial stewardship, hospitals in Indonesia will open up opportunities for further research, including studies of cause-effect relationships in the using of antimicrobial stewardship digital tools.

Question 23. Why have you measured the use of Reserve type of antibiotics?

Reserve category, in our opinion, also should be a target, which prescribing must be reduced wisely. But this manuscript is more giving attention in shifting prescription from Watch to Access category, because in Indonesia the Watch category antibiotics now become big issue, which it maybe the biggest group of antibiotic that's prescribed by clinicians. We hope, in the next day, shifting prescription from Watch to Access category antibiotic can also give the good impact for reducing the Reserve category antibiotics

Question 24. What strategies would the authors suggest for scaling the e-RASPRO system to other hospitals, particularly those without prior experience in manual RASPRO?

In our opinion, the key for expanding e-RASPRO to other hospitals is socialization. We can create a customized digital antibiotic guideline on e-RASPRO based on patient risk stratification, local microbial patterns, synthesis of various literature, WHO AWARE and drug availability in hospitals. All of these things must be agreed upon with intra-hospital experts and be socialized together. Manual RASPRO and e-RASPRO has same flow chart.
So, If an agreement has been reached, then e-RASPRO can be socialized without previous use of manual RASPRO system, and the use of digital e-RASPRO can be used directly. Currently e-RASPRO has been used in > 30 hospitals in Indonesia and we are still continuing to carry out observations involving the relevant intra-hospital experts.

Question 25. How does the study ensure that the reported decreases in antibiotic use do not compromise patient care, especially for high-risk patients in Type III risk stratification?

Before we collected data for this study, we confirmed each hospital that there were no adverse events in patients included in the type III risk stratification group.
In addition, the e-RASPRO device does not reduce the priority of using antibiotics which is needed in type III risk stratification patients. Through the e-RASPRO system, patients with type III risk stratification are guaranteed to receive antibiotics as are written in the e-RASPRO digital guidelines as be agreed by internal hospital experts.
The decrease in the use of antibiotics in the Watch category, in our opinion, may still be caused by the fact, in both hospitals, during the study, it was noted that > 80% of patients included into the type I risk stratification group (as we will state in our revise manuscript). So, it is not because the hospitals deliberately withheld the use of necessary antibiotics in patients with type III risk stratification

Question 26. The e-RASPRO tool relies on collaboration across clinicians, pharmacists, and nurses. How does the study address potential challenges in interdisciplinary communication, particularly in urgent situations?

In conditions where there is no agreement between the clinician, pharmacist and the hospital's antimicrobial stewardship team in administering antibiotics, while rapid drug administration is needed (in patients with sepsis who fall into the type III risk stratification category), then antibiotic can be dispensed as was recommended by the clinician. However, through the e-RASPRO device, pharmacist can create notes on the device for this situation. The administration of antibiotics with pharmacist notes can be reviewed in the following days. All of these notes can be traced by e-RASPRO device when evaluation is carried out next day. All of these data can be used as evaluation material for developing action plan for better future improvements. (STATEMENT IS ADDED IN MANUSCRIPT)

Question 27. What are the potential impacts of integrating the e-RASPRO system with electronic health records, and has the tool been tested for compatibility with existing hospital systems?

e-RASPRO was created as an *Application Programing Interface* (API) ready, this device can be used in parallel or integrated with every hospital information system. However, at the beginning of use, it is recommended for using e-RASPRO in parallel with the hospital information system. After using habit is developed, then e-RASPRO can be fully integrated into the hospital information system.

Reviewer #3:

QUESTION 28. Is e-RASPRO tool widely used in your country? Is e-RASPRO tool used in any other country?

Currently e-RASPRO has been used in > 30 hospitals in Indonesia and we are still continuing to carry out observations involving the relevant intra-hospital experts. e-RASPRO does not yet be used outside Indonesia

QUESTION 29. Could you provide the relevant version or software information of e-RASPRO？

This e-RASPRO software was taken from manual RASPRO flowchart which was created by RASPRO Indonesia Study Group for Antimicrobial Stewardship and Resistance. We created this tool and socialized it, made some internal hospital expert peer review, focus group discussion, and made sure it can be used by hospitals. After feedback was given, we tried to make it better and re-socialized. You can contact RASPRO Indonesia Study Group via our email: ypri.raspro@yahoo.com for further information, and we are open for collaboration as long as it's for better antimicrobial stewardship implementation.

QUESTION 30. The screenshot images of the software application interface in the article are not very clear, and the characters inside are basically unreadable, at least in the PDF file I reviewed. I hope it can be improved.

We already fix the screenshot images, hopefully it will be better and you can see it clearly, sir.

RESEARCH ARTICLE

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A survey on define daily dose of watch- and access-category antibiotics in two Indonesian hospitals following the implementation of digital antimicrobial stewardship tool

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ABSTRACT

Background: In 2023, the World Health Organization (WHO) began targeting a shift in antibiotic prescribing trends from Watch to Access category. The expected target is including 60% of antibiotic prescribing in the Access category.

Method: This survey was a preliminary study, in which our study group designed a digital model of antimicrobial stewardship and the model was known as e-RASPRO. It was an initial review on the implementation of e-RASPRO tool prior to its wider use in future hospitals. The survey on the use of antibiotic Define Daily Dose / 100 patient days (DDD) was carried out in two hospitals in Indonesia at 3 months and 9 months of use, respectively. Hospital 1 as a primary hospital, Hospital 2 as a referral hospital. Data was retrieved retrospectively at the inpatient wards of both hospitals.

Result: Three months before and after the implementation of e-RASPRO in Hospital 1, we found an increase in DDD of prophylactic antibiotic Cefazolin by 167.18 %. In hospital 2, it could not be described because Cefazolin had been used since the hospital applied the manual RASPRO concept. DDD of Watch category antibiotics within 9 months following the implementation of e-RASPRO tool in hospital 1 showed a decrease of 49.01 %. Meanwhile, the implementation of e-RASPRO for 3 months in Hospital 2 still showed an increase in Watch category antibiotics by 20.18 %; however, there was a decrease in DDD of Cephalosporin and Glycopeptide antibiotics by 7.63 % and 49.30 %, respectively. In the meantime, as a way of saving antibiotic use and shifting antibiotic prescribing to the Access category, we found a decrease in DDD of Access category antibiotics in Hospital 1 by 3.64 % and an increase in Hospital 2 by 8.14 %

Conclusion: The survey may indicate that there are savings attempts in antibiotic use as well as an early change in DDD antibiotics from the Watch category to the Access category following the implementation of e-RASPRO tool in both hospitals. The time period of using the digital devices may still affect the results; however, this survey certainly has not illustrated a strong cause-and-effect correlation between the use of e-RASPRO tool and antibiotic DDD.

Introduction

The World Health Organization (WHO) in 2023 began to set the target of prescribing Access antibiotics at 60 % of reach.[1,2] It certainly must be followed by supporting efforts in various sectors such as the hospital management sectors, human resources, knowledge of antibiotics and various other supporting devices. Some studies suggest that the use of antimicrobial stewardship tools can provide good results in terms of antimicrobial use and reducing antibiotic DDD; however, it may not be possible to determine what kind of digital model is good to use.[3,4].

WHO has categorized antibiotics into Access, Watch and Reserve (AWARE).[5] The Access category includes antibiotics that are considered to have a lower potential for resistance compared to the Watch category.[2] While Reserve category antibiotics are types of antibiotics that are only used if there are suspected

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infections caused by Multi-Drug Resistant (MDR) pathogens.[2] Therefore, Reserve category antibiotics are antibiotics that the use must be restricted in accordance to the necessity.[5] The WHO AWaRe became a reminder to stakeholders for promoting antimicrobial appropriate use and antimicrobial stewardship with consideration of local epidemiology and antimicrobial sensitivity data.[6].

RASPRO Indonesia Study Group has tried to develop a digital device by integrating the AWARE antibiotic category based on what has been launched by WHO. The use of this tool is intended to guide clinicians in administering prophylactic, empiric and definitive antibiotics. Moreover, it also facilitates consultation with the hospital's Antimicrobial Stewardship Team (*PCA*) in coordinating the approval of administering antibiotics of Watch and Reserve categories, helping hospitals to monitor, evaluate report and create action plans related to antibiotic use.

Method

This survey was the initial result of a review on the implementation of e-RASPRO tool prior to its wider use in future hospitals. The socialization on implementation of e-RASPRO tool along with a guideline on digital antimicrobial use was carried out at two hospitals in Indonesia. The e-RASPRO tool in Hospital 1 was an initial device (blueprint); while in Hospital 2 it was a full-version device. However, both of them had the same flow, only different on the screen display. These two hospitals were chosen because they have different status in service. Hospital 1, a primary hospital with 134 beds, 9 pharmacists, 115 nurses, and 37 specialist doctors. Hospital 2, a referral hospital with 254 beds, 39 pharmacists, 368 nurses, and 102 specialist doctors.

Digital antimicrobial usage guideline was made based on literature synthesis and observation of local microorganism pattern (in hospitals that already hold data on microorganism patterns) by entering antibiotic categories in accordance with the AWARE-WHO. The guideline on digital antimicrobial usage was then agreed by hospital management and the hospital's Antimicrobial Resistance Control Committee / *Komite Pengendalian Resistensi Antimikroba* (*KPRA*), which was then included in the e-RASPRO tool.

The e-RASPRO was then implemented in both hospitals and used to guide clinicians in prescribing prophylactic, empiric and definitive antibiotics. At 9 months and 3 months following the implementation of e-RASPRO, the define daily dose (DDD) of antibiotics was calculated and evaluated whether there was a change in the pattern of antimicrobial use before and after the implementation of the e-RASPRO tool from the Watch category to the Access category.

Prescribing prophylactic antibiotics

When prescribing prophylactic antibiotics, clinicians were asked to fill out a digital prophylaxis form of e-RASPRO tool and they were then guided to select the type of prophylactic antibiotic according to the digital antimicrobial guidelines included in the device with the main target use was Cefazolin (Fig. 1).

Prescribing empiric antibiotic

When prescribing empiric antibiotic using e-RASPRO tool, clinicians were guided to determine the risk stratification of patients who were hospitalized in inpatient wards by filling out the Risk Stratification digital form. The digital form was created by considering the patients' immune status, their severity of infection and medical history such as: history of previous antibiotic use, history of previous hospitalization and history of previous medical instrument use. The e-RASPRO tool categorized patients into 3 risk stratification groups for empiric antibiotic administration (Fig. 2).

Type I Risk Stratification Group was a group of patients that could receive empiric antibiotics for multi-sensitive microorganism coverage. This group was a group of immunocompetent patients or could also be a group of immunocompromised patients with the severity of bacterial infections that were not threatening or at risk of MDR and they were not included in Type II and III Risk Stratification Groups.[7].

Type II Risk Stratification Group for non-severe infectious condition with ((Immunocompromised AND/OR uncontrolled diabetes mellitus) with (History of antibiotic administration within ≤ 90 days ago AND / OR History of having treatment in healthcare facilities of ≥ 48 h, ≤ 90 days ago, AND / OR History of medical instrument use of ≤ 90 days ago)). Type II Risk Stratification group was a group which was at risk of infection with Multi Drug Resistant (MDR) microorganisms – *Extended Spectrum Beta-Lactamases* (ESBLs).[7–15].

Type III Risk Stratification Group was a group with threatening infectious condition AND / OR ((Immunocompromised AND / OR uncontrolled diabetes mellitus) with (History of antibiotic administration ≤ 30 days ago AND / OR History of having treatment in healthcare facilities of ≥ 48 h ≤ 30 days ago, AND / OR History of medical instrument use ≤ 30 days ago)). This group is at risk of infections by ESBLs and other Multi-Drug Resistant (MDR) microorganisms including MDR *Pseudomonas* sp and others.[7,16–21].

The group of patients with Healthcare Associated Infections (HAIs) was also included in the Type III Risk Stratification group. The group categorized as HAIs was a group with a period of infection occurrence at ≥ 48 h treatment in a healthcare facility, even at 90 days following a surgery.[22–25] Moreover, a research with a limited scope of study demonstrated that patients included in the Type III Risk Stratification in the RASPRO system were also the group that was at risk for sepsis.[26].

The digital guidelines on the use of empiric antimicrobial agents in both hospitals were developed similiarly. Patients who were digitally categorized as those with Type I Risk Stratification on the e-RASPRO tool, were given a choice of antibiotics listed in the digital guidelines on Access-categorized Single or Combination antimicrobial agents (e.g. Ampicillin, Ampicillin Sulbactam, Amikacin dan Gentamycin).[5] Meanwhile, for the group of patients with Type II Risk Stratification on the e-RASPRO tool, the choice of empiric antibiotics was anti-ESBL antibiotics with a choice of antibiotics included in the Access-Watch category on the digital guidelines of antimicrobial agents or also with a consideration on the use of Carbapenem Sparing Regimen (e.g. Piperacillin Tazobactam or Amoxicillin Clavulanate / Ampicillin Sulbactam + Aminoglycosides combination). The use of Quinolone only for patients who were allergic to Penicillin or with other considerations).[5] The group of patients with Type III Risk Stratificationon the e-RASPRO tool had a choice of antibiotics of those that were able to eradicate ESBLs or other MDR bacteria with the majority of antibiotic choices listed on the digital guidelines of antimicrobial agents including those of Access, Watch to Reserve category (e.g. Meropenem with or without combination with Aminoglycosides to Polymixin and Tygecycline).[5] The digital guidelines on empiric antimicrobial use, which had been developed on the device, included a guideline on using antimicrobial agents, particularly using the third generation of Cephalosporin as minimum as possible. It was correlated to the developing issues in both hospitals on the high incidence of using the third generation of Cephalosporin. Escalation and de-escalation, as well as step up and step down empiric antibiotics were also carried out by filling out the digital form of digital guidelines on antibiotics that could provide guidance for clinicians. In

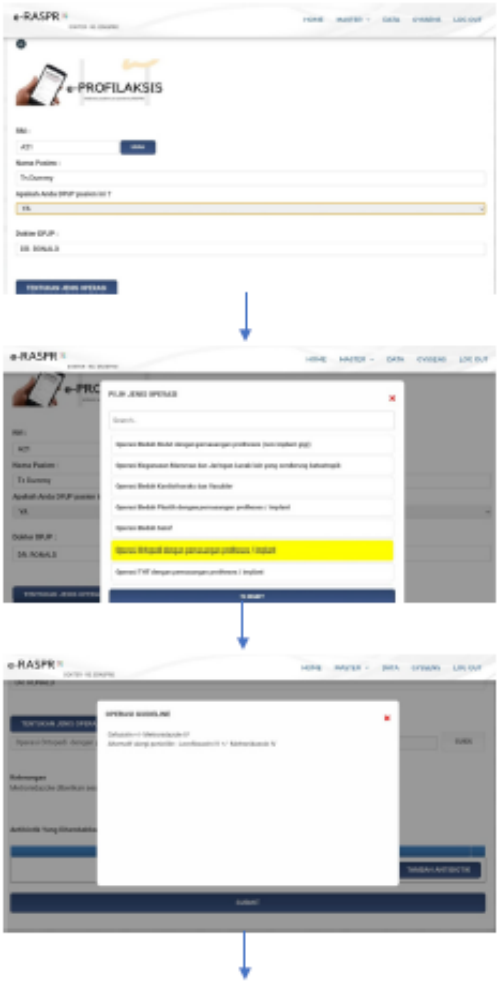
addition, the dose of antibiotics that had been administered, the presence or absence of adjustment dose would also be documented on the device.

Prescribing definitive antibiotics

To de-escalate antibiotics treatment according to culture results (definitive antibiotics), the e-RASPRO tool had also included a digital form for administering definitive antibiotics that must be filled out by the clinician. The digital form would indicate the time when antibiotic de-escalation had been carried out, how long it took to perform antibiotic de-escalation from empiric to definitive antibiotics, the type and the dose of definitive antibiotics used (Fig. 3).

When prophylactic and empiric antibiotics were not given in accordance with the digital antimicrobial guideline as well as the guideline on the use of Watch and Reserve category antibiotics, it would be consulted by the pharmacist to the hospital PGA team in order to determine whether or not the antibiotic was allowed bo be used. Prescribing definitive antibiotics categorized as Watch and Reserve must also be done by consulting the PGA team that could be facilitated by the system. Regarding prolonged antibiotic administration, clinician must complete an electronic form on prolonged antibiotic use (Fig. 4). If the form had not been completed or if there was no appropriate reason, the pharmacist could perform *Automatic Stop Order* (ASO). In difficult cases and when experiencing a change of antibiotics, either empirically or there was an antibiotic escalation, a special electronic form was provided so that it could become an integrated discussion among the clinician, the PGA and even hospital management team (Fig. 5).

By implementing the e-RASPRO tool, initial data was retrieved within the first 3 months of using e-RASPRO device to evaluate the suitability on the type of prophylactic antibiotics. The survey was then continued with data collection on DDD of antibiotics at 9 months before and after the use of e-RASPRO in Hospital 1 and



DOCTOR SCREEN:

Clinician STARTED filling out a digital form about prophylactic antibiotics

DOCTOR SCREEN:

Clinician determined the type of operation

DOCTOR SCREEN:

The device provided digital guidance on prophylactic antibiotic use to clinician

Fig. 1. Guideline on Digital Antibiotic Prophylaxis of e-RASPRO tool.

DOCTOR SCREEN:

The clinician prescribed prophylactic antibiotics based on the existing digital guidelines, wrote down the dose, the route of administration and then SUBMITTED.

PHARMACIST SCREEN:

After the clinician finished prescribing and SUBMITTED the prophylactic antibiotics, the prescription would go to the pharmacist. The pharmacist would verify: type, dose and route of administration in accordance to the digital guidelines.

If the prophylactic antibiotics given were not in accordance with the digital guidelines, the pharmacist could contact the Hospital PGA team via Whatsapp Call / Video Call. After approval, the pharmacist SUBMITTED the ordered prophylactic antibiotics.

NURSE SCREEN:

After the pharmacist SUBMITTED, the nurse would know the type of prophylactic antibiotics that would be used in accordance with the indication in the guidelines and the antibiotics had been approved for use by the pharmacist and the hospital PGA team. Nurses could also participate in monitoring the use of prophylactic antibiotics through the nurse screen.

Fig. 1 (*continued*)

3 months before and after the use of e-RASPRO tool in Hospital 2. Data was collected when Hospital 2 had only been using the e-RASPRO tool for 3 months.

After data collection had been completed, the data were presented descriptively and changes in antibiotic use patterns before and after the implementation of e-RASPRO tool were observed. Survey data was calculated and submitted to a pharmacist of each hospital and the data had been verified by the *KPRA* of each surveyed hospital. Data was presented as it was in accordance with those that had been submitted by each hospital.

Results

Within the first 3 months of using the e-RASPRO tool, data on DDD prophylactic antibiotic were retrieved. Efforts that had been made through e-RASPRO tool were to increase the use of Cefazolin as the main prophylactic antibiotic in accordance with the applicable regulations in Indonesia.

There was an increase in DDD of Cefazolin by 167.18 % with a decrease in DDD of Ceftriaxone and Cefotaxime by 9.98 % and 7.84 % respectively that served as prophylactic antibiotics in

DOCTOR SCREEN:

Clinician was asked to determine the indication of the antibiotic used: PROPHYLACTIC / EMPIRIC/DEFINITIVE

Clinician STARTED to fill out the digital form on empiric antibiotic

If EMPIRIC indication was selected, then the clinician was asked to determine the focus of infection

DOCTOR SCREEN:

After determining the focus of infection, clinician was asked to perform stratification

On the system, there would be a question regarding severity:

Did the patient have sepsis / Healthcare Associated Infections (HAIs), Febrile Neutropenia?

Did the patient have a threatening organ perforation?

Did the patient have impaired consciousness due to bacterial infection?

If there was nothing threatening, the system would ask whether there was a history of antibiotic use AND / OR Hospitalization ≥48 hours AND / OR the use of medical instruments in the last 30 OR 90 days?

When all questions had been answered, the system would convey information to the clinician about the patient's Risk Stratification along with the digital guidelines on whether Access/Watch/Reserve antibiotics must be given. The clinician could prescribe empiric antibiotics in accordance with digital guidelines along with the dose, route of administration and then SUBMITTED

Fig. 2. The Digital Guideline on Empiric Antibiotics (Empiric Antibiotics: The Initiation and Replacement or Addition of Antibiotic Types) on e-RASPRO Tool.

DOCTOR SCREEN:

In the future, if the clinician deemed that it would be necessary to escalate or step down empiric antibiotics (before definitive culture results were available), then the clinician could fill out additional form / changing empiric antibiotic. Adding / changing empiric antibiotic could be guided by the system based on the existing digital guidelines using Access/Watch/Reserve-based antibiotic categories. Clinician could prescribe empiric antibiotics, dose, route of administration and then SUBMITTED.

PHARMACIST SCREEN:

After the clinician finished prescribing and SUBMITTED the empiric antibiotic, the prescription would go to the pharmacist and the pharmacist would perform verification on: the Type, Dose and Route of administration.

If the empiric antibiotics given were not in accordance with the digital guidelines or if Watch/Reserve antibiotic must be given empirically, then the pharmacist could contact the Hospital PGA team via Whatsapp Call / Video Call. After approval, the pharmacist SUBMITTED the ordered empiric antibiotics.

NURSE SCREEN:

After the pharmacist SUBMITTED, the nurse would identify the type of empiric antibiotics that would be used in accordance with the indication in the guidelines and had been approved for use by the pharmacist and the hospital PGA team. Nurses could also participate in monitoring the use of empiric antibiotics through the nurse screen by filling out digital table each time the antibiotics had been given to the patient.

Fig. 2 (continued)

Hospital 1 at three months after implementing the e-RASPRO tool. Meanwhile, in Hospital 2 there was no use of Ceftriaxone and Cefotaxime as well as other antibiotics as prophylactic antibiotics. Cefazolin had been used since the socialization of the manual (non-electronic) RASPRO concept had been carried out in Hospital 2.

The survey on DDD of Watch-category antibiotics at 9 months and 3 months following the implementation of e-RASPRO tool in Hospital 1 and Hospital 2 was as followed: there was a decrease in DDD of Cephalosporin antibiotics by 51.25 % and 7.63 %, respectively. Meanwhile, there was also a sharp decrease in the DDD of Quinolone antibiotics in Hospital 1 by 46.71 %; however, a significant increase was still observed on the use of Quinolone antibiotics by 69.15 % in Hospital 2. The DDD of Carbapenem antibiotics in Hospital 1 seemed to decrease by 22.81 %; however, it increased

in Hospital 2 by 12.28 %. There was a decrease in total DDD of Watch antibiotics in Hospital 1 by 49.01 % and an increase of 20.18 % in Hospital 2.

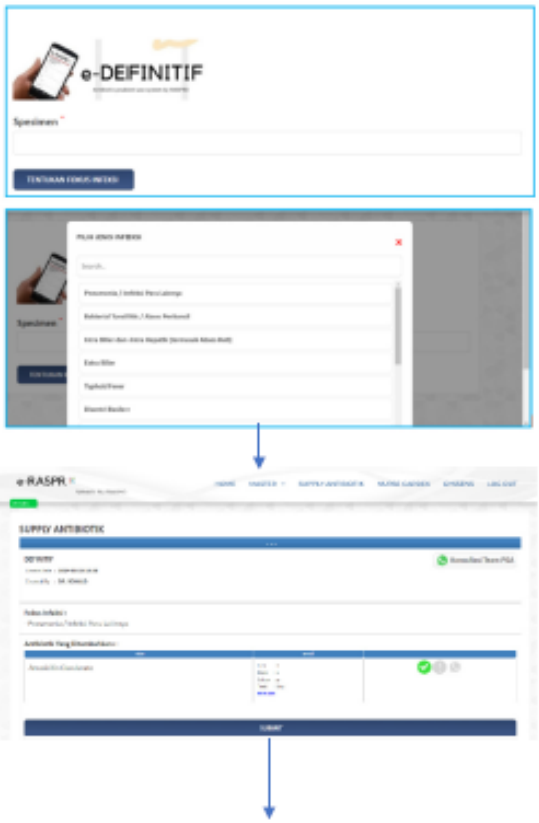
The survey on DDD of Access category antibiotics at 9 months and 3 months following the implementation of e-RASPRO tool in Hospital 1 and Hospital 2 was as followed: there was an increase in DDD of Ampicillin and Amoxicillin Clavulanate in Hospital 1 by 100 % respectively. Meanwhile, in Hospital 2 there was also a significant increase on the DDD of 1.5 g and 0.75 g Ampicillin Sulbactam by 126.25 % and 54.35 %. It had been documented that there was a decrease in DDD of Gentamycin in Hospital 1 by 80.90 %. A decrease in DDD of Metronidazole in Hospital 1 and Hospital 2 were recorded at 8.47 % and 11.60 %, respectively. There was a decrease in total DDD of Access-category antibiotics by 3.64 % in Hospital 1 and an increase of 8.14 % in Hospital 2. No exact data about number of difficult case or automatic stop order event, both hospitals have not implemented this policy strictly.

Discussion

Surveys related to Antimicrobial Resistance (AMR) and Antimicrobial Use (AMU) should be carried out to evaluate the effectiveness of policies, evidence and implementation of PGA.[27,28] In addition, specific intervention strategies are also needed in order to improve the wise use of antibiotics in Indonesia.[29] RASPRO Indonesia Study Group initially had tried to write a manual concept so that hospitals could carry out antimicrobial stewardship in a more targeted manner. In 2022, the manual concept was then developed into e-RASPRO digital tool, a digital device that could be used in integration or parallel with the hospital information system.

The digital tool is then used as a model that is expected to assist hospitals in guiding clinicians in the wise use of antibiotics based on WHO AWARE. It also considers local microorganism patterns (if the hospital has already had any representative microorganism patterns). The guideline on empirical antimicrobial use is digitized by considering patient risk stratification.

In addition, this digital device is able to record the suitability of empiric antibiotic use in accordance with the risk stratification of each patient, the suitability of changing empiric antibiotics based on local guidelines, antibiotics de-escalation time (administering antibiotics according to culture findings), the duration of antibiotic use until reaching the *antibiotic-time-out* period. The e-RASPRO tool also facilitates faster consultation with the pharmacists and clinician electronically via *What's App*, *What's App Call*, Video *Call* even using mobile phone with the hospital PGA team. The device can also assist the hospital in conducting integrative monitoring,



DOCTOR SCREEN:

When prescribing definitive antibiotics, clinician must fill out electronic form for definitive antibiotics, doses, route of administration as well as the focus of infection, types of specimen, and SUBMITTED

PHARMACIST SCREEN:

After the clinician finished prescribing and SUBMITTED the definitive antibiotic, then the prescription would go to the pharmacist. The pharmacist would perform verification on: the Type, Category Access/Watch/Reserve, Dose and Route of administration.

If the definitive antibiotics given were Watch/Reserve antibiotic, then the pharmacist could consult the Hospital Antimicrobial Stewardship team via Whatsapp Call / Video Call. After approval, the pharmacist could SUBMIT the ordered definitive antibiotics.

Fig. 3. The Definitive Antibiotic Form in e-RASPRO Tool.

NURSE SCREEN:

After the pharmacist SUBMITTED, the nurse would identify the type of definitive antibiotics that had been used and had been approved for use by the pharmacist and the Hospital Antimicrobial Stewardship team. Nurses could also participate in monitoring the use of definitive antibiotics through the nurse screen by filling out digital table each time the antibiotics had been given to the patient

Fig. 3 (continued)

retrieving data, performing reporting that are necessary to determine the next action plan related to the implementation of PGA.

On the e-RASPRO tool, clinicians who want to perform clean surgeries with prostheses or clean-contaminated surgeries or other surgeries with a high risk of infection can fill out an electronic form and they will be guided to use 2 g of Cefazolin. In a study conducted in Thailand, it has been found that 70 % of prophylactic antibiotic use is continued for more than a day.[30] The e-RASPRO tool can detect whether there is further use of antibiotics that should not be given if the status of initial antibiotic given is prophylactic antibiotic. The use of prophylactic antibiotics listed on the e-RASPRO tool is Cefazolin, which is in accordance with the applicable regulations in Indonesia.

Table 1 shows an increase in DDD of Cefazolin as a prophylactic antibiotic, which is followed by a decrease in the percentage of DDD of Ceftriaxone and Cefotaxime in Hospital 1 at 3 months following the implementation of e-RASPRO tool. This is indeed consistent with the goal that has been proclaimed nationwide that there should be a shift in the use of 3rd generation Cephalosporin antibiotics to Cefazolin (1st generation of Cephalosporin) that serves as prophylactic antibiotic. For Hospital 2, the use of Cefazolin as prophylactic antibiotic had been applied since the concept of manual RASPRO was introduced in the hospital about 1 year before the introduction of digital model of e-RASPRO tool; therefore, its impact could not be calculated. The decrease in the DDD percentage of Cefazolin as a prophylactic antibiotic may be related to the number of patients that have been undergone surgeries during the survey period.

Table 2 shows a decrease in DDD of 3rd generation Cephalosporin in both hospitals. At the beginning of implementation of e-RASPRO tool, the high incidence of antibiotic use of 3rd generation Cephalosporin was indeed a major issue in both hospitals. Some journals suggest that 3rd generation Cephalosporin is the most widely used antibiotics.[10–12] Therefore, a particular strategy is necessary to reduce its use, especially for its empiric use.

DDD of antibiotics of Quinolone group in Hospital 1 had a significant decrease of 46.71 %; while it still shows a striking increase of 69.15 % in Hospital 2. There is no certainty on why there is a stark difference between the two hospitals regarding the use of Quinolone. In the digital guideline on the use of antimicrobial agents in both hospitals, Quinolones have only been placed as an alternative treatment for Penicillin-allergic patients, who are also not recommended to be treated with Cephalosporin group, even Carbapenem group. The high use of Quinolones in Hospital 2 may be related to various issues such as: the subjective doctor's confidence on Access-category antibiotics in the management of mild infection cases (Type I and II Risk Stratification), drug availability, managerial strength on the compliance with antimicrobial use guidelines and others.

DDD of Carbapenem antibiotics has decreased by 22.81 % in Hospital 1, but it increased by 12.28 % in Hospital 2. Meanwhile, the DDD of Glycopeptide class in Hospital 2 has also decreased by 49.20 %. There has been no specific research on the causal correlation regarding the increased and decreased use of both antibiotic groups following the implementation of e-RASPRO tool. It may occur since the number of patients classified as Type III Risk Stratification could fluctuate.

Table 3. On Table 3, it can be seen that there is a decrease in DDD of Access-category antibiotics in Hospital 1, but in contrast, there is an increase of DDD in Hospital 2. For this, in our opinion, we could evaluate this issue from two sides. In Hospital 1, there is a positive side obtained, namely a decrease in total antibiotic DDD, both from Watch Category antibiotics, which decreases significantly by 49.01 %, and Access Category antibiotics which decreases by 3.64 %. The significant increase in DDD of Ampicillin and Amoxicillin Clavulanate by 100 % from the rate of 'never been used' is expected to be an indicator that e-RASPRO tool can guide clinicians in using Access-category antibiotics for non-severe infection cases, replacing the role of Watch antibiotics that so far have been massively used.

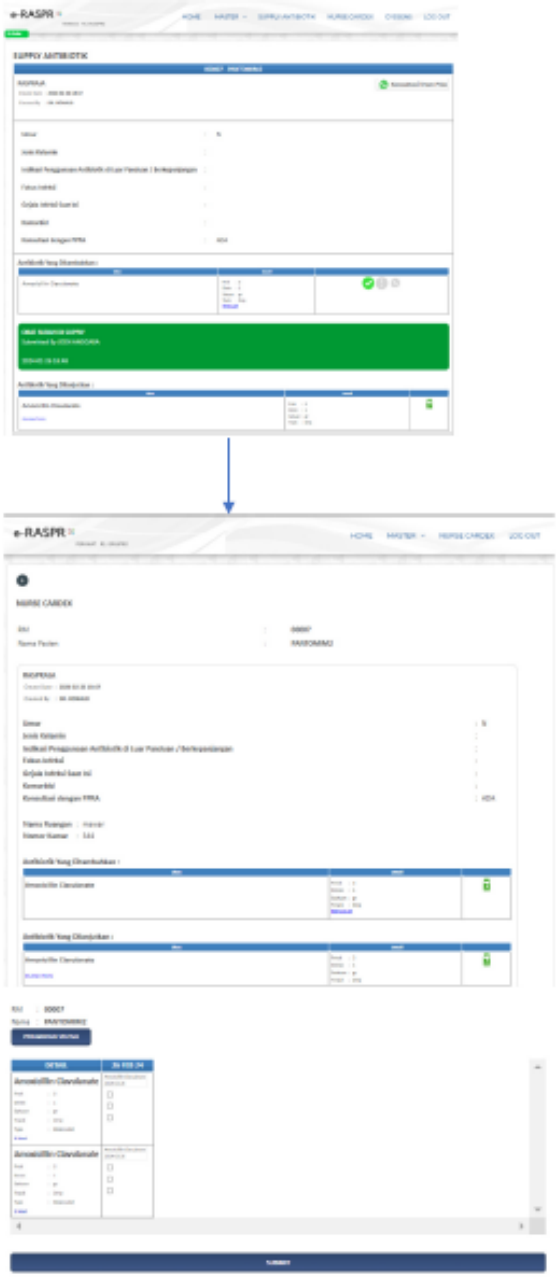
In Hospital 2, it can be seen that there is still an increase in total DDD of Watch-category antibiotics by 20.18 %; however, the increased DDD of Access-category is expected to be the beginning of a new culture of using Access-category antibiotics that one day may shift the dominance on the use of Watch-category antibiotics in accordance with its indication. The difference in the length of use of the e-RASPRO tool of 9 months and 3 months may still the one of causes of different results found in both hospitals. When there is a shift in prescribing from Watch to Access category antibiotics and decrease in antibiotic prescribing, hopefully, there will be

DOCTOR SCREEN:

On prolonged antibiotic use, clinician must complete the electronic form on prolonged antibiotic use along with the focus of infection, the patient's immune status and the reason followed by SUBMITTING.

On prolonged antibiotic use, if the digital form had not been complete, Automatic STOP Order could be considered by consulting with the Hospital PGA team

Fig. 4. Prolonged Antibiotic Form.



NURSE SCREEN:

After the pharmacist SUBMITTED, the nurse would identify the type of prolonged antibiotic used and had been approved for use by the pharmacist and the Hospital PGA Team. The nurse could participate in monitoring the use of prolonged antibiotics through the nurse screen by completing the digital table each time the antibiotic had been administered to the patient

Fig. 4 (continued)

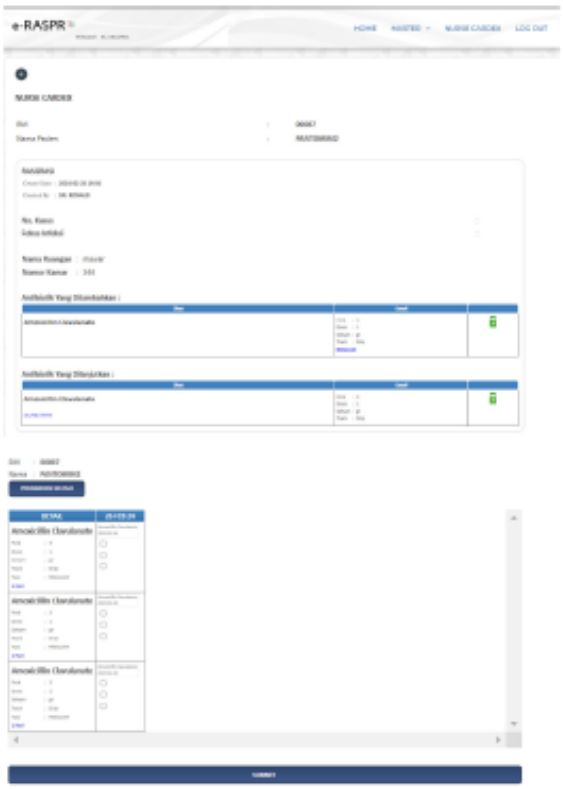
DOCTOR SCREEN:

When using antibiotics in difficult cases (condition other than the general guidelines), clinician must complete the electronic form of antibiotic use in difficult cases followed by SUBMITTING.

PHARMACIST SCREEN:

After the clinician finished SUBMITTED the form of antibiotic use in difficult cases, then the data would go to the pharmacist and the pharmacist would verify antibiotic use in difficult cases by consulting the Hospital PGA team via Whatsapp Call / Video Call. After approval, the pharmacist could SUBMIT the ordered antibiotics.

Fig. 5. The Form of Antibiotic Use in Difficult Cases.



NURSE SCREEN:

After the pharmacist SUBMITTED, the nurse would identify the type of antibiotic used in difficult cases and had been approved for use by the pharmacist and the Hospital PGA Team. The nurse could participate in monitoring the use of antibiotics in difficult cases through the nurse screen by completing the digital table each time the antibiotic had been administered to the patient.

Fig. 5 (*continued*)

Table 1
DDD of Prophylactic Antibiotics in Hospital 1 and Hospital 2 at 3 Months Following the Implementation of e-RASPRO Tool.

	Hospital 1			Hospital 2		
	3 Months			3 Months		
	Before Implementing e-RASPRO	After Implementing e-RASPRO	Increase / Decrease	Before Implementing e-RASPRO	After Implementing e-RASPRO	Increase / Decrease
Cefazolin	7.96	19.13	167.18 %	2.84	2.31	−18.66 %
Ceftriaxone	4.21	4.63	9.98 %	–	–	–
Cefotaxime	2.04	2.20	7.84 %	–	–	–

a decrease in the risk of selective pressure events which will reduce the risk of the emergence of MDR bacteria. However, it certainly needs further studies to come to such conclusion.

e-RASPRO able to record conditions where there is no agreement between the clinician, pharmacist and the hospital's antimicrobial stewardship team in administering antibiotics, while rapid drug administration is needed (in patients with sepsis who fall into the type III risk stratification category). In this condition, antibiotic can be dispensed as is recommended by the clinician. However, through the e-RASPRO device, pharmacist can create notes on the device for this situation. The administration of antibiotics with pharmacist notes can be reviewed in the following days. All of these notes can be traced by e-RASPRO device when evaluation is carried out next day. All of these data can be used as evaluation material to develop action plan for better future improvements.

Table 2
DDD of Watch Category Antibiotics in Hospital 1 and 2 at 9 Months and 3 Months Following the Implementation of e-RASPRO Tool.

	Hospital 1			Hospital 2		
	9 Months			3 Months		
	Before Implementing e-RASPRO	After Implementing e-RASPRO	Increase / Decrease	Before Implementing e-RASPRO	After Implementing e-RASPRO	Increase / Decrease
	Patients = 4215	Patients = 4618		Patients = 2805	Patients = 2675	
Ceftriaxone	484.00	217.95	−54.97 %	34.44	31.84	−7.55 %
Cefotaxime 1 g	12.19	18.84	54.55 %	5.28	4.84	−8.33 %
Cefotaxime 0.5 g	–	–	–	–	–	–
Ceftazidime	–	–	–	2.65	3.06	15.47 %
Cefoperazone	–	–	–	–	–	–
Cefoperazone sulbactam	–	–	–	–	0.64	100.00 %
Ceftizoxime	–	5.11	>100 %	0.42	–	−100.00 %
Cefepime	–	–	–	5.58	4.30	−22.94 %
Cephalosporine Group	**496.19**	**241.90**	**−51.25 %**	**48.37**	**44.68**	**−7.63 %**
Levofloxacin 750 mg	**195.51**	**84.11**	**−56.98 %**	**8.55**	**21.41**	**150.41 %**
Levofloxacin 500 mg	**56.52**	**33.89**	**−40.04 %**	**23.83**	**24.10**	**1.13 %**
Ciprofloxacin	–	16.31	100.00 %	–	9.26	**100.00 %**
Moxifloxacin	–	–	–	–	–	–
Quinolone Group	**252.03**	**134.31**	**−46.71 %**	**32.38**	**54.77**	**69.15 %**
Meropenem 1 g	20.30	15.67	−22.81 %	8.27	9.43	**14.03 %**
Meropenem 0.5 g	–	–	–	9.64	10.68	**10.79 %**
Carbapenem Group	**20.30**	**15.67**	**−22.81 %**	**17.91**	**20.11**	**12.28 %**
Vancomycin 0.5 g	–	–	–	1.42	0.72	**−49.30 %**
Glycopeptide Group	–	–	0.00 %	1.42	0.72	**−49.30 %**
TOTAL Watch=	**768.52**	**391.88**	**−49.01 %**	**100.08**	**120.28**	**20.18 %**

Table 3
DDD of Access-category Antibiotics in Hospital 1 and 2 at 9 Months and 3 Months Following the Implementation of e-RASPRO Tool.

	Hospital 1			Hospital 2		
	9 Months			3 Months		
	Before Implementing e-RASPRO	After Implementing e-RASPRO	Increase / Decrease	Before Implementing e-RASPRO	After Implementing e-RASPRO	Increase / Decrease
	Patients = 4215	Patients = 4618		Patients = 2805	Patients = 2675	
Ampicillin	–	9.13	100 %	–	–	–
Ampicillin Sulbactam 1.5 g	–	–	–	0.80	1.81	126.25 %
Ampicillin Sulbactam 0.75 g	–	–	–	1.38	2.13	54.35 %
Amoxycillin clavulanate	–	8.21	100 %	–	–	–
Gentamycin	20.89	3.99	−80.90 %	–	–	–
Amikacin	–	–	–	–	–	–
Metronidazole	24.78	22.68	−8.47 %	8.02	7.09	−11.60 %
Cefuroxime*	–	–	–	–	–	–
TOTAL Access=	**45.67**	**44.01**	**−3.64 %**	**10.20**	**11.03**	**8.14 %**

Conclusion

The survey may indicate that there are saving endeavors in antibiotic use as well as an early change in antibiotic DDD from the Watch category to the Access category following the implementation of e-RASPRO tool in both hospitals. The period of time of using the digital device may still affect the results. However, the survey certainly does not illustrate a strong cause-and-effect relationship between the use of e-RASPRO tool and antibiotic DDD.

CRediT authorship contribution statement

Ronald Irwanto Natadidjaja: Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Aziza Ariyani:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation. **Hadianti Adlani:** Writing – review & editing, Supervision, Investigation, Formal analysis, Data curation. **Raymond Adianto:** Software, Data curation. **Iin Indah Pertiwi:** Resources, Investigation, Data curation. **Grace Nerry Legoh:** Resources, Investigation, Data curation. **Alvin Lekonardo Rantung:** Resources, Investigation, Data curation. **Hadi Sumarsono:** Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ceh.2024.12.004.

References

1. Mudenda S, Daka V, Matafwali SK. World Health Organization AWaRe framework for antibiotic stewardship: Where are we now and where do we need to go? An expert viewpoint. *Antimicrob Steward Healthc Epidemiol*. 2023;3(1):1–3. https://doi.org/10.1017/ash.2023.164.

2. Zanichelli V, Sharland M, Cappello B, et al. The WHO AWaRe (Access, Watch, Reserve) antibiotic book and prevention of antimicrobial resistance. *Bull World Health Organ.*. 2023;101(4):290–296. https://doi.org/10.2471/BLT.22.288614.
3. Trotter NE, Slight SP, Kaimi R, et al. The effect of digital antimicrobial stewardship programmes on antimicrobial usage, length of stay, mortality and cost. *Informatics Med Unlocked.*. January 2023;2023(37). https://doi.org/10.1016/j.imu.2023.101183. 101183.
4. Van Dort BA, Penm J, Ritchie A, Baysari MT. The impact of digital interventions on antimicrobial stewardship in hospitals: A qualitative synthesis of systematic reviews. *J Antimicrob Chemother.*. 2022;77(7):1828–1837. https://doi.org/10.1093/jac/dlac112.
5. Infographics WA. *The WHO A Wa Re (Access, Watch, Reserve) Antibiotic Book*. World Health Organization; 2022. doi:{WHO/MHP/HPS/EML/2022.02}.
6. Chansamouth V, Inlorkham P, Keohavong B, et al. Implementing the WHO AWaRe antibiotic book guidance in lower-resource settings: the case of the Lao PDR. *JAC-Antimicrobial Resist.*. 2024;6(1):1–6. https://doi.org/10.1093/jacamr/dlae004.
7. Natadidjaja RI, Henry T, Adlani H, Ariyani A, Bur R. Antibiotic usage at a private hospital in Central Java : results of implementing the Indonesian Regulation on the Prospective Antimicrobial System (Regulasi Antimikroba Sistem Prospektif Indonesia [RASPRO]). *Int J Infect Control.*. 2021;17(1):1–10. https://doi.org/10.3396/ijic.v17.20411.
8. Ben-Ami R, Rodríguez-Baño J, Arslan H, et al. A multinational survey of risk factors for infection with extended-spectrum β-lactamase-producing enterobacteriaceae in nonhospitalized patients. *Clin Infect Dis.*. 2009;49(5):682–690. https://doi.org/10.1086/604713.
9. Marchaim D, Gottesman T, Schwartz O, et al. National multicenter study of predictors and outcomes of bacteremia upon hospital admission caused by Enterobacteriaceae producing extended-spectrum β-lactamases. *Antimicrob Agents Chemother.*. 2010;54(12):5099–5104. https://doi.org/10.1128/AAC.00565-10.
10. Johnson SW, Anderson DJ, May DB, Drew RH. Utility of a Clinical Risk Factor Scoring Model in Predicting Infection with Extended-Spectrum β-Lactamase-Producing Enterobacteriaceae on Hospital Admission. *Infect Control Hosp Epidemiol.*. 2013;34(4):385–392. https://doi.org/10.1086/669858.
11. Aliberti S, Di Pasquale M, Zanaboni AM, et al. Stratifying risk factors for multidrug-resistant pathogens in hospitalized patients coming from the community with pneumonia. *Clin Infect Dis.*. 2012;54(4):470–478. https://doi.org/10.1093/cid/cir840.
12. Cipponi N, Bellone P, Aliberti S, et al. Prevalence, risk factors and outcomes of patients coming from the community with sepsis due to multidrug resistant bacteria. *Multidiscip Respir Med.*. 2019;14(23):1–11. https://doi.org/10.1186/s40248-019-0185-4.
13. Hayakawa K, Gattu S, Marchaim D, et al. Epidemiology and risk factors for isolation of escherichia coli producing ctx-m-type extended-spectrum-lactamase in a large U.S. Medical Center. *Antimicrob Agents Chemother.*. 2013;57(8):4010–4018. https://doi.org/10.1128/AAC.02516-12.
14. Vance MK, Gretella DA, Ward LM, Vijayvargiya P, Garrigos ZE, Wingler MJB. Risk Factors for Bloodstream Infections Due to ESBL-Producing Escherichia coli, Klebsiella spp., and Proteus mirabilis. *Pharmacy.*. 2023;11(2):74. https://doi.org/10.3390/pharmacy11020074.
15. Goyal D, Dean N, Neill S, Jones P, Dascomb K. Risk factors for community-acquired extended-spectrum beta-lactamase-producing Enterobacteriaceae infections--a retrospective study of symptomatic urinary tract infections. *Open Forum. Infect Dis.*. 2019;6(2). https://doi.org/10.1093/ofid/ofy357.
16. Gomila A, Shaw E, Carratalà J, et al. Predictive factors for multidrug-resistant gram-negative bacteria among hospitalised patients with complicated urinary tract infections. *Antimicrob Resist Infect Control.*. 2018;7(1):1–11. https://doi.org/10.1186/s13756-018-0401-6.
17. Falcone M, Russo A, Giannella M, et al. Individualizing risk of multidrug-resistant pathogens in community-onset pneumonia. *PLoS One.*. 2015;10(4):1–16. https://doi.org/10.1371/journal.pone.0119528.
18. Musikatavorn K, Chumpengpan C, Sujiporn C. Risk factors of extended-spectrum beta-lactamase-producing Enterobacteriaceae bacteremia in Thai emergency department: A retrospective case-control study. *Asian Biomed.*. 2011;5(1):129–138. https://doi.org/10.5372/1905-7415.0501.016.
19. Patolia S, Ahate G, Patel N, Patolia S, Frey S. Risk factors and outcomes for multidrug- resistant Gram-negative bacilli bacteremia. *Ther Adv Infect Dis.*. 2018;5(1):11–18. https://doi.org/10.1177/2049936117727497.
20. Seligman R, Ramos-Lima LF, Oliveira V, do A, Santvicente C, Sartori J, Pacheco EF. Risk factors for infection with multidrug-resistant bacteria in non-ventilated patients with hospital-acquired pneumonia. *J Bras Pneumol.*. 2013;39(3):339–348. https://doi.org/10.1590/s1806-37132013000300011.
21. Prina E, Ranzani OT, Polverino E, et al. Risk factors associated with potentially antibiotic-resistant pathogens in community-acquired pneumonia. *Ann Am Thorac Soc.*. 2015;12(2):153–160. https://doi.org/10.1513/AnnalsATS.201407-305OC.
22. Haque M, Sartelli M, Mckimm J, Abu BM. Health care-associated infections–an overview. *Infect Drug Resist.*. 2018;11(1):2321–2333. https://doi.org/10.2147/IDR.S177247.
23. Revelas A. Healthcare - associated infections: A public health problem. *Niger Med J.*. 2012;53–64(2):59. https://doi.org/10.4103/0300-1652.108543.
24. Cardoso T, Almeida M, Friedman ND, et al. Classification of healthcare-associated infection: a systematic review 10 years after the first proposal. *AJIC Am J Infect Control.*. 2014;12(40):1–13. https://doi.org/10.1186/1741-7015-12-40.
25. . *Clean Care Is Safer Care*. 2011. www.who.int.
26. Natadidjaja RI, Kusuma AS, Sudradjat GB, Nugrohowati L. The Association between Medical History-based Risks and Sepsis Events in Immunocompromised Patients according to Type III Stratification of the Indonesian Regulation on the Prospective Antimicrobial System (Regulasi Antimikroba Sistem Prospektif / RASPRO). *Bull Med J.*. 2021;10(3):1031–1036. https://doi.org/10.15562/bmj.v10i3.2561.
27. Otto SJG, Haworth-Brockman M, Mazga-Rodriguez M, Wiersbowski A, Saxinger LM. Integrated surveillance of antimicrobial resistance and antimicrobial use: Evaluation of the status in Canada (2014–2019). *Can Vet J.*. 2022;63(2):161–170. https://doi.org/10.17269/s41997-021-00600-w.
28. Bennani H, Gornemben L, Stärk KDC, Häsler B. Evaluating Integrated Surveillance for Antimicrobial Use and Resistance in England: A Qualitative Study. *Front Vet Sci.*. 2021;8(November):1–16. https://doi.org/10.3389/fvets.2021.743857.
29. Limato R, Lazarus G, Demison P, et al. Optimizing antibiotic use in Indonesia: A systematic review and evidence synthesis to inform opportunities for intervention. *Lancet Reg Heal - Southeast Asia.*. 2022;2(6):1–23. https://doi.org/10.1016/j.lansea.2022.05.002.
30. Anugulruengkitt S, Charoenpong L, Kulthanmanusorn A, et al. Point prevalence survey of antibiotic use among hospitalized patients across 41 hospitals in Thailand. *JAC-Antimicrobial Resist.*. 2023;5(1):1–10. https://doi.org/10.1093/jacamr/dlac140.
31. Menkem EZ, Labo Nanfah A, Takang T, et al. Attitudes and Practices of the Use of Third-Generation Cephalosporins among Medical Doctors Practicing in Cameroon. *Int J Clin Pract.*. 2023;2023:1–7. https://doi.org/10.1155/2023/8074413.
32. Harish G, Tankovic J, Boelle PY, et al. Are third-generation cephalosporins unavoidable for empirical therapy of community-acquired pneumonia in adult patients who require ICU admission? *A Retrospective Study. Ann Intensive Care.*. 2017;7(1):4–11. https://doi.org/10.1186/s13613-017-0259-4.