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# Identifying medication-related readmissions: Two students using tools vs a multidisciplinary panel

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## Abstract

**Background:** Polypharmacy may result in medication-related readmissions (MRRs). Identifying MRRs is time consuming. Screening of readmissions by students could increase efficiency for healthcare professionals. Recently, two screening tools have been published: the Assessment Tool for identifying Hospital Admissions Related to Medications (AT-HARM10) tool and the Drug-Related Admission (DRA) adjudication guide. It is unknown whether pharmacy students could identify MRRs with these tools.

**Objective:** To compare the agreement between two pharmacy students applying the AT-HARM10 tool and DRA adjudication guide in identifying MRRs vs a multidisciplinary panel.

**Methods:** A retrospective study was conducted from February to July 2020 at OLVG hospital. Readmissions within 30 days after discharge from seven departments were reviewed by a multidisciplinary panel (pharmacists and physicians). MRRs were defined as readmission where medication was the main cause or medication significantly contributed to the readmission. Two 5th year pharmacy-students volunteered to blindly apply both tools individually on all MRRs and a random sample of non-MRRs. The consensus results of the students and the multidisciplinary panel were compared and displayed as a percentage and Cohen's kappa (κ).

**Results:** Three hundred sixty-six readmission cases were selected in total, consisting of 181 MRRs and 185 non-MRRs. The agreement between the students using the AT-HARM10 tool vs the multidisciplinary panel was moderate (80%, $\kappa = 0.60$ (95% confidence interval (CI): 0.52-0.68)). The DRA adjudication guide had a moderate agreement (81%, $\kappa = 0.62$ (CI: 0.54-0.70)). Students misclassified MRRs mainly because the multidisciplinary panel found disease progression more profound than a contribution of medication.

**Conclusions:** Two students have an overall agreement of 80% in comparison with the multidisciplinary panel with a moderate Cohen's kappa. Students are more often overestimated, but they may be a good option to preselect potential MRRs to save time for healthcare professionals. However, some MRRs will be missed.

Tristan Coppes and Jozien van der Kloes contributed equally to this article and should be considered the joint first author.

  

## 1 | INTRODUCTION

Studies have shown that hospital readmissions have a big impact on patients and are a costly occurrence.[1] Medication can be the main cause or significantly contribute to readmission.[2-4] A recent systematic review stated that medication-related readmissions (MRRs) rates varied from 3% to 64% (median: 21% [14%-23%]).[5] These results indicate that a fair proportion of readmissions are medication-related.

So far, no standardised assessment of causal associations between medication and hospital readmissions exists to identify MRRs. The most common method of identifying MRRs is a review of patient records, including laboratory values and the medication history by hospital physicians and/or pharmacists.[5-9] It is thought that using a multidisciplinary panel reduces the blind spots of individual healthcare professionals while reviewing readmissions.[6] However, this approach is time consuming.

A solution to identify MRRs time efficiently could be the use of screening tools. Recently, two tools have been developed to identify MRRs in hospitals: the *Assessment Tool for identifying Hospital Admissions Related to Medications* (AT-HARM10) and the drug-related admission (DRA) adjudication guide.[10,11]

AT-HARM10 tool is a validated tool that includes ten yes or no questions to determine whether admission is medication-related.[10] An example of a question of the AT-HARM10 tool is: "Are there abnormal laboratory results or vital signs that could be medication-related and might have caused the admission?".

The DRA adjudication guide includes 26 triggers (eg, falls, fracture). This guide was developed using Delphi techniques, and open questions for a standardised chart review that helps users to identify MRRs, step-by-step, in older people.[11] However, the DRA adjudication guide has not been validated extensively yet.[11]

As identifying MRRs is an extra task for healthcare professionals, students may offer a solution by using these screening tools to initially identify MRRs. So far, only the AT-HARM10 tool has been validated to be applied by under-or post-graduate pharmacy students.[10] This validation study showed that students were able to filter MRRs with Cohen's kappa's values from 0.45 to 0.75.

However, this study only included readmissions of patients over 65 years old from the internal medicine department and was conducted with a limited number of readmissions (n = 100).

Before the AT-HARM10 tool and DRA adjudication guide are applied in daily practice, research needs to assess if the tools used by students are reliable against a multidisciplinary panel.

Therefore, the aim of this study was to compare the agreement between students applying the screenings tools in identifying MRRs vs a multidisciplinary panel in readmissions from seven hospital wards. Other objectives included the quantification of over- and underestimations of MRRs by students, the sensitivities and the specificities of students using the tools, the inter-rater reliability between students and the classification and quantification of differences between the students using the tools vs a multidisciplinary panel.

**What's known**

- Identifying medication-related readmissions (MRRs) is complex and a time-consuming task for healthcare professionals.
- The screening tools AT-HARM10 and DRA adjudication guide have recently been developed to identify MRRs.

**What's new**

- Using screening tools and discharge letters, two pharmacy students identified 80% of MRRs. Students more often overestimated the role of medication.
- In daily practice, review of readmissions by students can result in a smaller proportion of cases being reviewed by healthcare professionals. However, some MRRs will be missed. This might be reduced by providing students access to the health information system.

## 2 | METHODS

### 2.1 | General study design and setting

This retrospective study was conducted in OLVG, a general teaching hospital in Amsterdam, the Netherlands. The study was performed from February to July 2020 and was approved by the local review board of the hospital (Advies Commissie Wetenschappelijk Onderzoek – Medische Ethische Commissie (ACWO-MEC), registration number: 16-028, approval date: 16 December 2019). All patient data was handled in accordance with Dutch privacy regulations.

### 2.2 | Inclusion and exclusion criteria

Readmission cases used in this current study were assessed for their medication-relatedness by a multidisciplinary panel in a previous study (inclusion from June 2016 till February 2018).[12] Patients were included in this previous study if they met all following criteria: age of 18 years or older; index admission at OLVG at one of the seven participating departments (ie, pulmonology, surgery, cardiology, internal medicine, gastro-enterology, psychiatry and neurology); and the readmission occurred within 30 days after the index admission and was unplanned. The index admission was defined as chronologically the first admission of the patient during the inclusion period, which could have been planned or unplanned.

Patients were excluded if they were transferred to another hospital at index admission; if they revisited an emergency department or coronary care unit without an actual hospital admission; if they discharged themselves against hospital advice; if the readmission was because of a suicide attempt; or if the readmission was not clinically related to the index admission. The readmission was defined as clinically related if an underlying reason for the readmission was

**TABLE 1** Classification of differences between students applying the tools and the multidisciplinary panel

| Classification | Definition |
|---|---|
| Disease progression rather than a contribution of medication | An error of judgement concerning the role medication played in the readmission of the patient. Disease progression played a bigger role in the admission according to the panel |
| Lack of knowledge students | Students did not recognise the contribution of medication, as for example a side effect was unknown or the interpretation of a laboratory result was incorrect |
| Crucial information is absent in a discharge letter | The information needed to assess the medication-relatedness of readmission was missing/incorrect in the discharge letter but present in the hospital information system (eg, information on non-adherence based on refill data of community pharmacies) |
| Human error | Students overlooked/missed information regarding (the contribution of) medication stated in a discharge letter |

plausibly related to the care of the patient, or if patient actions were rendered during or immediately following a prior hospital admission. An example of an unrelated readmission is pneumonia during index admission followed by a car accident which cannot be related to actions or medication prescribed during the index admission.

## 2.3 | Multidisciplinary panel and information sources

Both a physician-researcher and the resident of each department assessed whether readmission was clinically related to the index admission. Any differences were resolved by reaching a consensus. Included readmissions were individually reviewed by residents from the participating wards, including a hospital pharmacy resident, using a review tool developed based on literature.[12,13] Hereafter, all residents from the eight departments, including hospital pharmacy, held multidisciplinary discussions to reach a consensus on whether a case was medication-related or not. Finally, the readmission cases that were classified as medication-related were validated by a senior internist and senior clinical pharmacologist/hospital pharmacist. The result of the final validation step is referred to as the "multidisciplinary panel."

The information sources of one readmission case consisted of the discharge letter of the index admission, the discharge letter of the readmission or the emergency department letter and medical notes of clinical visits in between the index admission and readmission if applicable. If not included in the discharge letter, a list of medications the patient was using just prior to an index admission and after the index admission was present. The multidisciplinary panel also had access to the electronic hospital information system (including adherence to medications based on dispensing data of the patient's community pharmacy and latest laboratory results).

## 2.4 | Application of tools by students, case selection and information sources

In the Netherlands, the Doctor of Pharmacy (PharmD) degree requires six years of study, three years for the bachelor's degree and three years for the master's degree. The 3-year master's programme contains at least 30 weeks of internship in (hospital) pharmacies.

OLVG interviewed several pharmacy students who had volunteered for this study and selected two students, who were in their fifth year of pharmacy training and had similar scholar performances. They had individual introduction training about both tools before they were applied. A scheduled training session had been carried out which included an instruction presentation of the tools, and for the DRA adjudication guide, a YouTube tutorial video was watched.[14] Hereafter, the students assessed six training cases, randomly selected by the supervisor, to practice both the DRA adjudication guide and the AT-HARM10 tool, see Appendices 1 and 2 for the tools. The results of the training cases were discussed with the supervisor.

After the training cases were finished, the students first applied the AT-HARM10 tool and then the DRA adjudication guide individually on a selection of hospital readmission cases. For the readmission case selection, the supervisor selected all MRRs identified by the multidisciplinary panel and a similar random number of non-MRRs. At the time of reviewing the students were unaware of which cases were medication-related and which were not medication-related. Nor were the students aware of the proportion of MRRs in the selected sample.

Any differences between students were discussed and resolved. The students discussed the case with the supervisor if consensus could not be met. Ten cases were discussed with the supervisor.

The students had access to the same information sources as the multidisciplinary panel, with an exception of the information present in the electronic hospital information system. Therefore, students mainly relied on discharge letters.

## 2.5 | Classification of differences between the tools and the multidisciplinary panel

The results of MRRs identified by the multidisciplinary panel were revealed to the students after they applied the tools on all the readmission cases. The MRRs identified by students using the tools were compared with MRRs identified by the multidisciplinary panel.

Whenever the reasoning of the multidisciplinary panel was not clear, the supervisor was consulted. If the students and supervisor did not agree with the reasoning of the multidisciplinary panel, the senior internist and senior clinical pharmacologist/hospital pharmacist were asked to re-evaluate the readmission.

Differences between the assessment of students and the multidisciplinary panel were discussed after the results of the multidisciplinary panel were presented to the students. During this discussion, categories were formed and the differences were classified into mutually exclusive categories, see Table 1.

### 2.6 | Outcomes

The primary outcome of this study was the agreement of both tools applied by pharmacy students vs the multidisciplinary panel in identifying MRRs, shown as a percentage and Cohen's kappa, including the 95% confidence interval (CI). Secondary outcomes consisted of the over- and underestimations of MRRs by students, the sensitivities and specificities of students using the tools, the inter-rater reliability between students and the reason for differences between the students vs the multidisciplinary panel.

### 2.7 | Data-analysis

During this study, there was no evidence to support a sample size calculation for this population. The sample size was dependent on the number of cases available.

The primary analysis consisted of determining the agreement between the students using the tools and the multidisciplinary panel, using a Cohen's kappa (κ). Kappa values range from 0 until 1. A kappa value can be interpreted as follows: 0-0.20 none, 0.21-0.39 minimal, 0.40-0.59 weak, 0.60-0.79 moderate, 0.80-0.90 strong and above 0.90 reflects almost perfect agreement.[15] Over- and underestimations of MRRs by students were counted and the sensitivities and specificities of the students using the tools vs the multidisciplinary panel were calculated. Furthermore, the inter-rater reliability between students applying the tools was also calculated using Cohen's kappa.

Descriptive statistical analysis was performed using a statistical package for the social sciences (SPSS) version 22.0 (IBM SPSS, Chicago, IL, USA). Other descriptive outcomes were analysed in Microsoft Excel. Normally and non-normally distributed variables were displayed as a mean with standard deviation (SD) or median with inter-quartile range (IQR), respectively.

## 3 | RESULTS

In the previous study, 1111 cases were included. Exclusions were mainly because of unrelated readmissions or attempted suicide. The multidisciplinary panel regarded 181 cases as medication-related. A random sample of 185 non-MRRs was added, which resulted in 366 readmission cases that were reviewed by students, see Figure 1.

### 3.1 | Baseline characteristics

Table 2 describes the patient and admission related characteristics of all the cases included in this study (n = 366) and shows that these were comparable between MRRs (n = 181) and non-MRRs (n = 185). The median age within each group was 70 years. The overall percentage of females was 47.8.

### 3.2 | Student vs multidisciplinary panel

The overall agreement between the AT-HARM10 tool by student consensus and the multidisciplinary panel was 80%, with a Cohen's κ value of 0.60 (95% CI: 0.52-0.68). The strength of agreement was moderate. For the DRA Adjudication guide, the overall agreement was 81% and the Cohen's κ value was 0.62 (95% CI: 0.54-0.70), which was a moderate agreement (see Table 3).

### 3.3 | Under- and overestimation, sensitivity and specificity

With the AT-HARM10 tool, students overestimated 39 readmission cases as MRRs, while the multidisciplinary panel identified these as non-MRRs. The students underestimated 34 MRRs that the multidisciplinary panel identified as MRRs. This resulted in a sensitivity and specificity for the AT-HARM10 tool of 81% (95% CI: 75%-87%) and 79% (95% CI: 72%-85%), respectively. Students using the DRA adjudication guide overestimated 38 readmission cases and underestimated 32 MRRs. This resulted in a sensitivity and specificity of 82% (95% CI: 76%-88%) and 79% (95% CI: 73%-85%), respectively, for the DRA adjudication guide.

### 3.4 | Interrater-reliability between students

The inter-rater reliability test between the two students resulted in a Cohen's κ of 0.70 for the AT-HARM10 tool and in a κ of 0.68 for the DRA adjudication guide, both kappa's are considered a moderate agreement.

### 3.5 | Reason for differences between multidisciplinary panel and students

After comparing the identified MRRs of the students with the multidisciplinary panel, two readmissions were sent for re-evaluation by the senior internist and senior clinical pharmacologist/hospital pharmacist. One of these readmissions, initially classified as non-MRR by

**FIGURE 1** Flow chart of selection of readmission cases

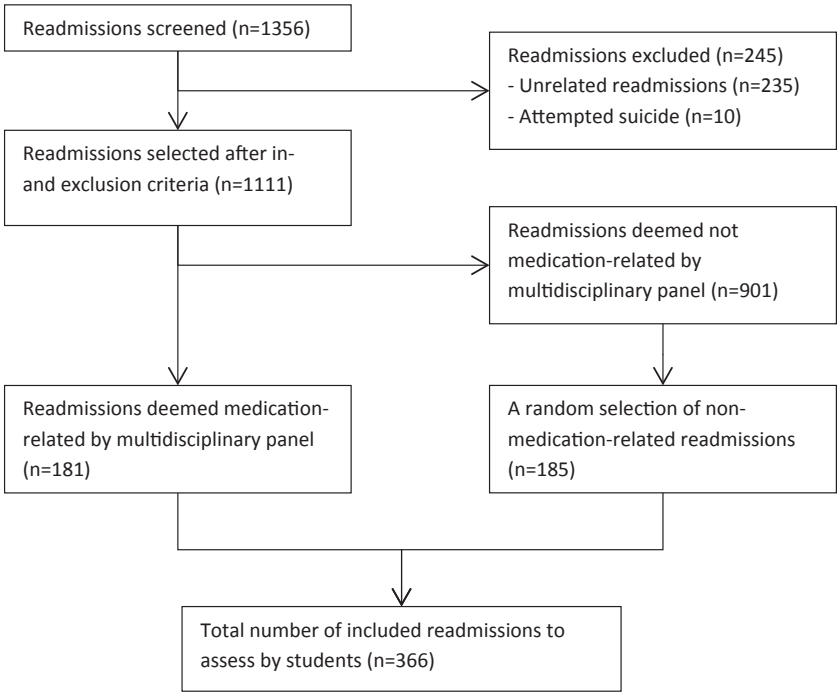


**TABLE 2** Patient and admission related characteristics (n = 366 readmissions)

| Variable | All readmissions (n = 366) | MRR (n = 181) | Non-MRR (n = 185) |
|---|---|---|---|
| Female sex, n (%) | 175 (47.8) | 80 (44.2) | 95 (51.4) |
| Age, median years [IQR] | 70 [59-79] | 70 [62-78] | 70 [57-80] |
| Median number of medications at discharge of index admission, n [IQR] | 10 [7-14] | 11 [8-15] | 9 [6-14] |
| Index admission duration, median, days [IQR] | 5 [2-11] | 5 [2-13] | 5 [2-11] |
| Index admission ward | | | |
| Internal medicine, n (%) | 106 (29.0) | 69 (38.1) | 37 (20.0) |
| Lung, n (%) | 74 (20.2) | 36 (19.9) | 38 (20.5) |
| Surgery, n (%) | 69 (18.9) | 22 (12.2) | 47 (25.4) |
| Cardiology, n (%) | 59 (16.1) | 31 (17.1) | 28 (15.1) |
| Gastroenterology, n (%) | 42 (11.5) | 19 (10.5) | 23 (12.4) |
| Neurology, n (%) | 14 (3.8) | 3 (1.7) | 11 (5.9) |
| Psychiatry, n (%) | 2 (0.5) | 1 (0.6) | 1 (0.5) |

Abbreviations: MRR, medication-related readmission; Non-MRR, non-medication-related readmission.

the panel, was adjusted to MRR. This leads to an adjusted number of in total 72 differences between the students applying the AT-HARM10 tool and the multidisciplinary panel. For the DRA adjudication guide, the adjusted number of differences was 69.

The main reason for differences between the students and the panel was because the multidisciplinary panel found that disease progression played a major role instead of medication use (35% of differences). In 34% of MRRs were missed because of lack of knowledge of students or because of a human error (ie, overlooking information in discharge letters).

The multidisciplinary panel had access to patient records and the students used discharge letters as their main source. In 31% of the missed MRRs by students the information for identifying the MRR was present in the patient records, but not in discharge letters (eg, information on non-adherence, latest laboratory results, the complete medication list).

## 4 | DISCUSSION

This is the first study that compares the results of students using the AT-HARM10 tool and DRA adjudication guide with the results of a multidisciplinary panel. This study shows that students can use these tools to identify 80% of readmissions with moderate

**TABLE 3** Agreement and performance values of identified medication-related readmissions between students using the tools and the multidisciplinary panel

| | AT-HARM10 | DRA Adjudication guide |
|---|---|---|
| Students vs multidisciplinary panel | | |
| Overall agreement (%) | 80 | 81 |
| Cohen's kappa, κ (95% CI) | 0.60 (0.52-0.68) | 0.62 (0.54-0.70) |
| Sensitivity students vs multidisciplinary panel, % (95% CI) | 81 (75-87) | 82 (76-88) |
| Specificity students vs multidisciplinary panel, % (95% CI) | 79 (72-85) | 79 (73-85) |

Abbreviations: AT-HARM10, Assessment Tool for identifying Hospital Admissions Related to Medications; CI, confidence interval; DRA, drug-related readmission.

Cohen's kappa values (AT-HARM10 $\kappa = 0.60$; DRA adjudication guide $\kappa = 0.62$).

The assessment of causal associations between medication and hospital (re)admissions is complex and requires a lot of time. Tools to facilitate this assessment may be used in studies on medication-related readmissions, and perhaps in clinical practice. Pharmacy students could be used to rule out non-MRRs which give healthcare experts a smaller proportion of cases to be reviewed and this could increase the feasibility of identifying MRRs in daily practice. Misclassifications of MRRs by students could be reduced by providing students access to patient records and using the health information system instead of discharge letters. In this study, we noted that discharge letters can be incomplete or miss crucial information regarding the complete medication list, non-adherence or latest laboratory results. In addition, students identified an extra MRR that was initially missed by the multidisciplinary panel. When extrapolated to the total amount of readmissions (n = 1111), this could mean that the multidisciplinary panel might have missed approximately five MRRs. This could be caused by the time pressure of healthcare professionals as they reviewed the readmission cases in addition to their daily practice.

The results of the AT-HARM10 tool in this study ($\kappa = 0.60$) show similarities with the results found in Kempen et al,[10] where the Cohen's kappa between students ranged from 0.45 to 0.75. In the study of Kempen et al different pairs of students assessed the same cases and as a consequence, a range of Cohen's kappa, sensitivity and specificity results were found. Our study showed that the AT-HARM10 tool applied by students had a sensitivity and specificity of 81% and 79%, respectively. These results show similarity with the results displayed in Kempen et al where the results showed sensitivities ranging from 70% to 86% and specificities ranging from 70% to 74%. It is important to note that the study of Kempen et al only included patients older than 65 years. Our study shows that roughly the same results are obtained when the AT-HARM10 tool is used on a population from 18 years and older. This may be explained by the fact that the tool is designed to identify every possible medication-related event, so the MRRs in a population younger than 65 years are also identified.

So far, there are no studies that have reported the use of the DRA adjudication guide by students compared with a multidisciplinary panel. Therefore, these outcomes could not be compared with other literature.

The inter-rater reliability between the students using the AT-HARM10 and the DRA adjudication guide the agreement was moderate ($\kappa = 0.70$ and $\kappa = 0.68$, respectively). The moderate agreement found in this and the Kempen et al[10] study suggests that the results by students can be reproduced. This could mean that work could be divided over different students, leading to a less time-consuming job. However, it needs to be taken into account that both students in this study were in the fifth year of their pharmacy education. Therefore, it needs to be considered that the agreement between students using the tools is probably related to their similar background.

There could be large differences in results between first-year students and students who are almost graduating. Differences may also occur between countries as pharmacy training may differ.

Students using the tools can over- and underestimate the amount of MRRs. The overestimation of the tool may be explained by the fact that the tools have no degree or scale to assess the medication-relatedness of readmissions, so some cases might be identified as an MRR, but disease progression may play a bigger role. Nevertheless, a multidisciplinary panel might still want to evaluate these readmissions to make sure no MRRs are missed. The underestimation can be explained by the lack of complete information in discharge letters and the lack of knowledge of students. This underestimation can partly be reduced by providing students access to the complete patient file of a patient instead of only the discharge letters. However, this will increase the time needed for applying the tools by students.

A strength of this study is the fact that two students independently applied the tools on a large set of MRRs from different departments. Another strength is the good reliability of the comparator: the multidisciplinary panel identified MRRs using a two-step approach, which includes a validating step with an internist and clinical pharmacologist/hospital pharmacist.

However, there are also limitations to this study. The first limitation includes the fact that both students applied both tools to the same cases and could therefore be influenced by the outcome of the first tool when applying the second tool. This carry-over effect was limited by applying the AT-HARM10 tool first. This tool only consists of 10 yes or no questions, where the DRA-adjudication guide requires more time and is excessively more elaborate. This could cause different insights which were not identified while using the AT-HARM10 tool. In addition, this study tried to show the capability of students using assessment tools to identify MRRs, not to compare the two applied tools with each other. We felt that it was important for students to have a consensus meeting, such as the multidisciplinary panel. As a result of time and budget constraints, it was not

possible to include more students to fully eliminate the chances of a carry-over effect. Secondly, only two students applied the tools in this study which limits the generalisability. However, in the AT-HARM validation study students were also capable of using the AT-HARM10 tool. Nevertheless, more studies are needed for robust conclusions on both tools. Thirdly, students are dependent on the quality of information in the discharge letters and therefore limited to the information noted in the discharge letters at the time.

To further confirm the applicability of the students using assessment tools in daily practice, further research should be conducted in different centres in different countries with different students (eg, medical students) and different years of education. Also, this paper did not focus on the differences between the tools. However, further study could help to determine which tool is more user-friendly in daily practice.

In conclusion, this study showed that after training students were able to detect a fair portion of MRRs using the AT-HARM10 tool and the DRA adjudication guide.

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## DISCLOSURE

There are no conflicts of interest to declare.

## ETHICS APPROVAL

The study was approved by the local review board of the hospital (Advies Commissie Wetenschappelijk Onderzoek – Medische Ethische Commissie (ACWO-MEC), registration number: 16-028, approval date: 16-12-2019). All patient data was handled in accordance with Dutch privacy regulations.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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