**UNIVERSITY OF MEDICINE AND PHARMACY**
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PHARMACY FIELD

# MODERN APPROACHES WITHIN THE PHARMACEUTICAL ACT IMPACTING PATIENTS' HEALTH

ABSTRACT OF THE DOCTORAL THESIS

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# INTRODUCTION AND GENERAL PART

The INTRODUCTION shows that the role of the pharmacist has evolved continuously over time, in line with scientific progress, the development of pharmaceutical services, and the changes that have occurred in medical practice, while remaining in an ongoing process of adaptation and expansion.

The profession of pharmacist is a boundary profession, situated at the interface of medicine, biology, chemistry, physics, pharmacology, engineering, and microbiology. Initially, physicians were also pharmacists. The words pharmacy, pharmacology, and the entire word family derive from the Greek term *pharmakon*, which has an ambivalent meaning: it can signify a remedy or medicine, but also a poison. *Pharmakon* may be either a remedy or a poison depending on the dose and context, just like medicines. The symbol of pharmacy, the "Bowl of Hygeia," originates in Greek mythology (1). Social evolution is directing the pharmacist toward the provision of pharmaceutical services. The pharmacist is, or should become, an essential filter within the medical system.

The present work had the following objectives:

1. To emphasize the pharmacist's role as an essential filter through the provision of pharmaceutical services.
2. To develop an information technology solution that standardizes pharmaceutical counseling and documents the provision of pharmaceutical services, while also improving pharmacist–patient–physician communication.
3. To highlight the value of the databases accessible to pharmacists for investigating possible adverse reactions.
4. To design a method that allows adverse reactions to be detected in routine practice while meeting criteria of accuracy, simplicity, clarity, and ease of use.
5. To design a rapid method for antibiotic susceptibility testing intended for critically ill patients, for whom time is a very important parameter.

The work addresses the following themes:

1. **Pharmaceutical service** – In this research, I aimed to emphasize the pharmacist's role as an "essential filter in the medical system" (2) and the pharmacy as a "health care point." I evaluated the health status of pharmacy patients with regard to blood pressure, blood glucose, uric acid, obesity, diagnoses, and medicines used. The results are also presented in the article **"Prevalence of Hyperuricemia and the Evidence-Based Impact Factors on Serum Uric Acid Levels"** (3). At the same time, I developed an IT solution, the **Integrated Information System "The Pharmacist's Recommendation"**, intended to facilitate pharmacist–patient–physician communication, improve adherence, and document the delivery of the pharmaceutical service.
2. **Pharmacovigilance** – Pharmacovigilance, although part of the pharmaceutical service, occupies a distinct place in this work. In this chapter, I addressed pharmacovigilance from two perspectives:
    a. analysis of electronic databases, highlighting the association medication administered (indapamide) – possible adverse reaction (hyperuricemia) – treatment of hyperuricemia (allopurinol), as an indirect method of analyzing a possible pharmacovigilance signal;
    b. the algorithms used in detecting adverse reactions. The assessment of the adverse reaction hypothesis is performed by the treating physician in the clinical context, who determines the therapeutic approach.

    The assessment of the adverse reaction hypothesis is performed by the treating physician in the clinical context, who determines the therapeutic approach. I developed **ARDRA** and **ARDRA-S**, including the online website www.ardra.ro, for the evaluation of adverse reaction risk.
3. **R-METSA – A rapid electronic method for testing susceptibility to antibiotics or antifungals**

    Starting from a simple principle, namely the metabolism of microorganisms, and from the need to rapidly identify the therapeutically effective antimicrobial, I developed a method, a device, and a software program to evaluate antimicrobial susceptibility: R-METSA.

In choosing the research themes, both the high prevalence and mortality on the one hand, and the pharmacist's possibility to intervene on the other, were taken into account.

Cardiovascular diseases rank first in prevalence among the population and also in the number of deaths they generate (4–6).

The research and development activities carried out required collaboration with professionals from multiple fields: programmers, mechanical engineers, electronics engineers, software engineers, microbiologists, and physicians; the work therefore has a strongly multidisciplinary character and combines knowledge from several domains.

## 1. Pharmaceutical Service

**Chapter 1** analyzes the current state of pharmaceutical services,

Subchapters 1.1 and 1.2. analyze the state of knowledge regarding hypertension, hyperuricemia and risk factors for hyperuricemia, respectively the IT solutions used by patients.

## 2. Pharmacovigilance

**Chapter 2** addresses the issue of pharmacovigilance, iatrogenic hyperuricemia, the analysis of records in the "EHR" databases and the available scales for confirming adverse reactions. In order to improve the detection/identification of adverse reactions, Naranjo et. al. developed the "Naranjo" scale in 1981 (7).

To assess the presence of adverse reactions, health professionals also have the WHO scale at their disposal, the aspects pursued by it being: chronological correlation of events, absence of other causes, "dechallenge" and "redechallenge" (8,9).

WHO is open/interested in researchers/health professionals being actively involved in the detection of adverse reactions, as reflected in the initiative "Joining the WHO Programme for International Drug Monitoring (WHO PIDM)" (10)".

The usefulness of the Naranjo scale is highlighted in numerous studies (11–13). The Naranjo scale contains 10 questions and is available online at https://www.evidencio.com/models/show/661.

There are a number of studies comparing the WHO scale and the Naranjo scale (14–16).

# 3. Considerations regarding microbiological diagnostic methods and antimicrobial susceptibility assessment

**Chapter 3** presents the methods available for antibiotic susceptibility testing.

Subchapter 3.1. "Common diagnostic methods for infections" presents the common, classical methods for testing antimicrobial susceptibility.

Subchapter 3.2. "Modern (unconventional) methods of microbiological diagnosis" presents the modern methods used in the diagnosis of infections.

Subchapter 3.3. "Modern (unconventional) methods of microbiological diagnosis" presents the research methods used in antimicrobial susceptibility testing.

# II. ORIGINAL CONTRIBUTION

## 4. Pharmaceutical Service

**Chapter 4** Addresses the complex issue of pharmaceutical service.

In this chapter, we analyzed the impact of pharmaceutical act on patients' health. In the study conducted, we evaluated blood pressure and uricemia:

Subchapter 4.1 "Evaluation of blood pressure within the screening service for diagnostic purposes in pharmacy (rapid testing)".

In this subchapter, we described a cross-sectional study on HTA conducted to establish the prevalence of HTA, determine therapeutic control, identify HTA-naive patients, but also to highlight the role of the pharmacist in patients' health. The initial categorical distribution of the group and the summary of demographic data are presented in Table below. Of the 377 people examined, 50.66% (n = 191) were classified in stage 0, which indicates normal blood pressure values or well controlled from a medical point of view at the time of evaluation. In contrast, almost half of the examined population (49.34%, n = 186) presented high values across the entire spectrum of hypertension. Of those with high values, 28.91% (n = 109) presented with stage 1 hypertension, 15.12% (n = 57) with stage 2, and 5.31% (n = 20) met the criteria for severe stage 3 hypertension. Of the total sample, a significant percentage of 40.05% (n = 151) entered the pharmacy with a known and pre-existing medical diagnosis of hypertension.

The majority of previously diagnosed individuals (n = 140, i.e. 92.71%) presented with blood pressure values below the threshold of 180/111 mmHg. A high-risk subgroup, representing 5.82% (n = 11) of the total 189 patients with elevated blood pressure, was formed by people with a known history of hypertension, but whose disease was inadequately controlled at the time of screening. Of the 20 patients identified with blood pressure values higher than 180/111mmHg, 45.0% (n = 9) were “naive” patients, having absolutely no idea about their health status, having no medical history of this condition; these patients represented 2.39% of the total sample examined.

The results of this screening exercise carried out in community pharmacies demonstrate the essential usefulness of opportunity medical checks carried out in pharmacies for identifying

cardiovascular risk. By assessing 377 unselected pharmacy customers, our screening successfully identified a collective prevalence of hypertension (stages 1–3) of 49.34%.

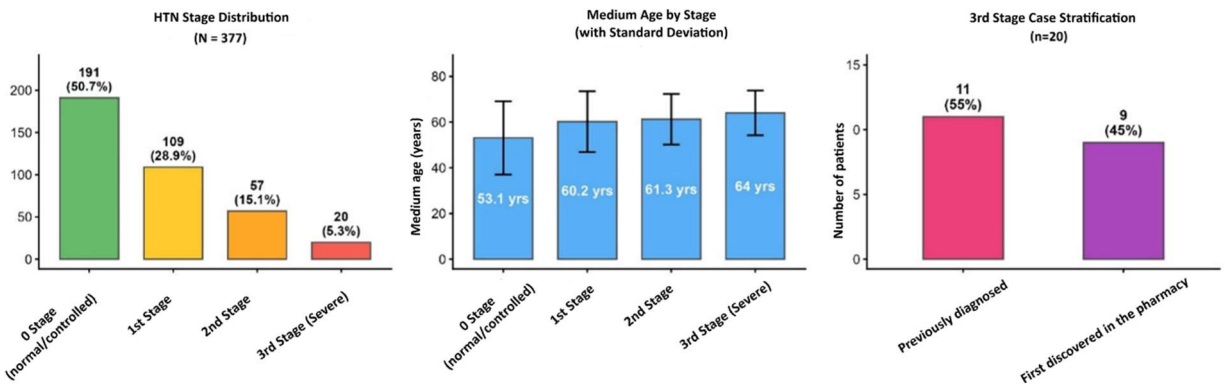
First, the detection of 11 individuals with a known medical history of hypertension, who presented critical blood pressure values (≥180/111 mmHg), highlights a rather serious situation. These patients suffer from uncontrolled hypertension, which may be caused by lack of therapeutic response, suboptimal doses, or poor medication adherence. In the pharmacy, the detection of these patients creates an immediate opportunity for pharmacist intervention, allowing medication synchronization, personalized counseling on adherence barriers, and medication review to guide treatment adjustment. Secondly, the identification in the pharmacy of 9 people who were not diagnosed, but had severe hypertension, is a valuable finding from a public health point of view.

The study failed to capture and mention the real number of patients with altered or dangerous values of BP, glycemia, uricemia or BMI who benefited from pharmaceutical services, but who did not accept inclusion in the study.

Of the 377 participants, 49.3% (n = 186) were identified as healthy volunteers, with no chronic diagnoses recorded.

Descriptive statistical summary of the distribution by age, stratified by HTN stage.

| **HTN stage** | **Number (n)** | **Proportion (%)** | **Medium age (± DS)** | **Median age** | **Interquartile range (IQR)** | **Age range [Min, Max]** |
|---|---|---|---|---|---|---|
| **Stage 0** | 191 | 50.66% | 53.1 ± 16.0 | 54 | 25 | [18, 89] |
| **Stage 1** | 109 | 28.91% | 60.2 ± 13.3 | 63 | 18 | [23, 88] |
| **Stage 2** | 57 | 15.12% | 61.3 ± 11.0 | 60 | 16 | [32, 84] |
| **Stage 3** | 20 | 5.31% | 64.0 ± 9.78 | 66 | 12.5 | [44, 82] |
| **Total** | **377** | **100.00%** | NA | NA | NA | [18, 89] |




Key findings from the pharmacy-based hypertension screening campaign

Subchapter 4.2 Evaluation of uric acid levels in the pharmacy diagnostic screening service (rapid testing)

This subchapter analyses the risk factors for hyperuricemia assessed by applying a health examination questionnaire to 377 participants aged 18 years or older and aimed to assess serum uric acid levels and their association with diagnosis, treatment and associated parameters, including systolic and diastolic blood pressure, pulse, height, weight and blood glucose.

The study included 377 participants, aged between 18 and 89 years, with a mean of 56.95 and an interquartile range of 48 to 69. The study group consisted of 55.17% women and 44.83% men. Of the patients, 181 were previously medication-naïve, while the remaining 196 were regularly taking between 1 and 9 different medications.

Of the 377 participants, 49.3% (n = 186) identified themselves as healthy volunteers with no chronic diagnoses recorded. Among those with known medical conditions, the largest subgroup was those with cardiometabolic and metabolic diseases, representing 40.1% (n = 151) of the entire group and nearly 75% of all diagnosed patients. Other medical conditions were much less common: musculoskeletal and gastrointestinal (GI) disorders each accounted for approximately 2.1% (n = 8 per category); specific neurological/psychiatric and cardiovascular conditions were present in 1.9% (n = 7) and 1.6% (n = 6) of participants, respectively. Gout, or known hyperuricemia, was diagnosed in only 1.6% (n = 6) of the group, while thyroid/autoimmune (n = 5), respiratory (n = 4) and renal (n = 2) conditions were underrepresented. Patients used a variety of medications.

A significant prevalence of hyperuricemia (40.4%) was found among people attending pharmacies in southern Romania, in many cases among those without a previous diagnosis or those taking potent diuretics such as indapamide. Our findings indicate that although height is an independent biological factor predicting high serum uric acid levels, the use of loop and thiazide diuretics remains a key modifiable element. The large number of undiagnosed cases highlights the essential role of community pharmacists in detecting people at risk through point-of-care testing. By incorporating screening services into standard pharmacy operations, healthcare professionals can promote earlier medical referrals and lifestyle changes, potentially reducing the long-term impact of associated cardiovascular, renal and metabolic conditions.

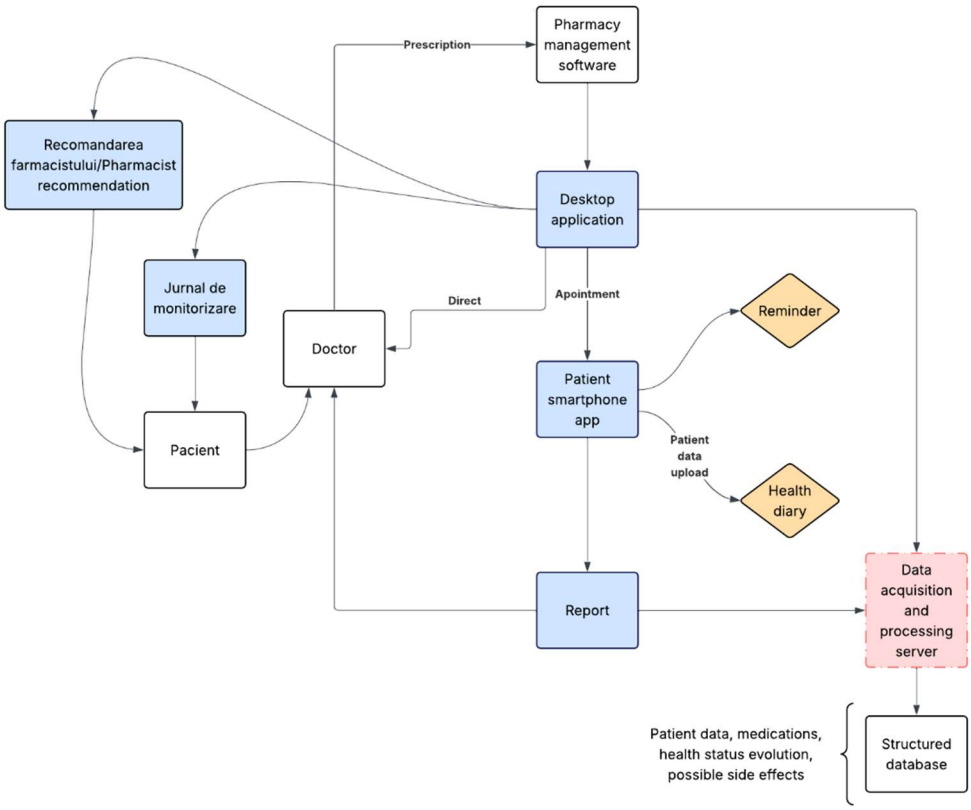
Subchapter 4.3 presents the "Pharmacist Recommendation" Information System, a developed and implemented "Pharmacist Recommendation" information system. The information application for pharmacists is available at www.recomandareafarmacistului.ro and the mobile application is available in Google Play.

The written document "Pharmacist Recommendation" contains at least the therapeutic regimen, the method of administering medications, health advice and recommendations, documents the pharmaceutical service provided. It prevents the wrong administration of medications. It streamlines pharmacist-patient communication and pharmacist-doctor communication. Pharmacist-doctor communication evolves from verbal communication through the patient to a written one that can be addressed directly to the treating physician. The written document can be submitted both in printed form and as a pdf format transmitted through modern means of communication. Another section of the desktop application refers to patient monitoring for BP, pulse, blood glucose, oxygen saturation, weight. The monitoring report is useful for the pharmacist/physician/patient in assessing the patient's progress and may contain relevant information that dictates the therapeutic approach. The information system and related documents have been designed to also address non-adherence issues. (17). The written document complies with the regulations in force, including the provisions of the RBPF (18).

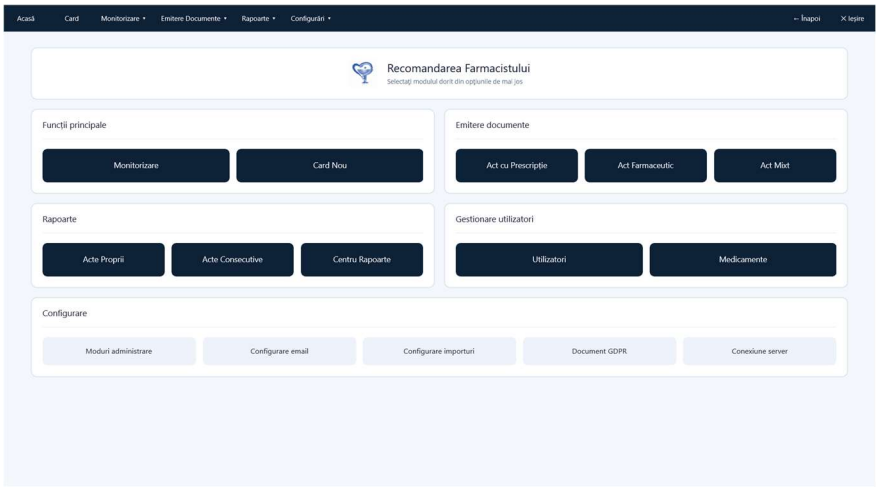
The mobile application is intended for patients who use modern technology, the main functions are medication administration reminder and health diary. It is based on the correct recording of data by the patient. It can contribute to a better awareness of the patient regarding

the evolution of the health status and the effectiveness of the treatment, but also allows the detection of possible adverse reactions mentioned in the health diary as the patient's evolution.

The figures below highlight the workflows in the computer system and the main screen of the Desktop application.

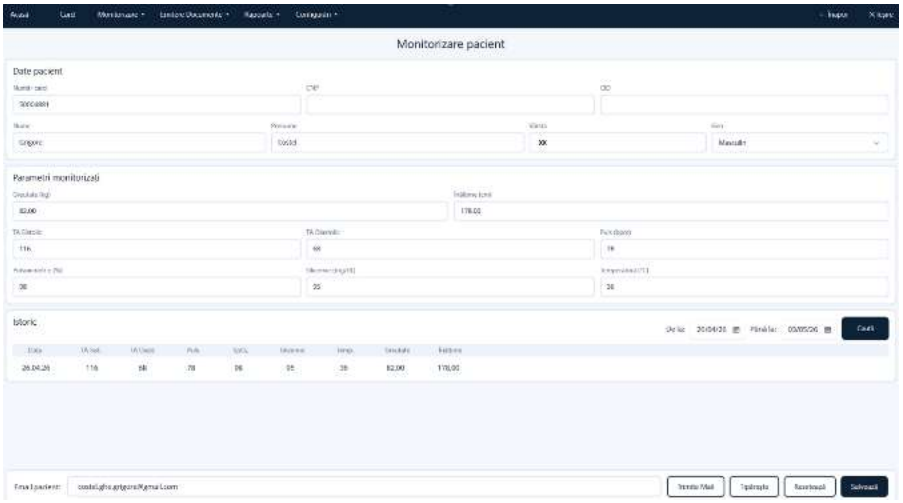



Data flow in the "Pharmacist Recommendation" information system




The main screen of the desktop application "Pharmacist Recommendation"

The application documents pharmaceutical counseling, monitoring or screening services, as seen in the figure below.



# 5. Pharmacovigilance

**Chapter 5** addresses the issue of pharmacovigilance.

Research in the field of pharmacovigilance has assumed two major directions in this chapter, namely database analysis and the development of ARDRA/ARDRA-S

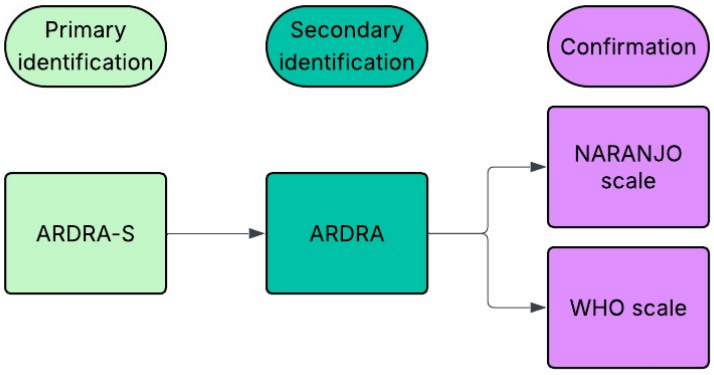
Subchapter 5.1 presents "Evaluation of the concomitant use of indapamide and allopurinol in pharmaceutical practice"

Recommendation of allopurinol is significantly associated with indapamide administration ($p = 0.003$) and daily dose of indapamide ($p = 0.018$, Table 5.2). Indapamide prescription is substantially associated with gender, age group and allopurinol dose ($p < 0.05$, Table 5.2). Significant associations were observed between indapamide dose, patient age and allopurinol dose ($p < 0.05$). In addition, daily dose of allopurinol was significantly associated with gender ($p < 0.05$).

Our findings show that 7.69% of prescriptions for indapamide 1.5 mg contain allopurinol (100 mg - 7.26% and 200 mg - 0.43%).

Subchapter 5.2 presents two algorithms developed within the doctoral thesis: Rapid Adverse Reactions Diagnostic Algorithm (ARDRA) and Rapid Adverse Reactions Diagnostic Algorithm Simplified (ARDRA-S).

The ARDRA and ARDRA-S algorithms are available at www.ardra.ro. The primary goal of developing ARDRA and ARDRA-S was to implement in current practice a rapid procedure for identifying potential adverse reactions and combating them. The role of the developed algorithms is as a coarse filter in identifying adverse reactions. If the scores obtained when applying ARDRA and/or ARDRA-S suggest a possible adverse reaction, the healthcare professional is directed to the use of other tools, namely the Naranjo scale (7) and the WHO scale (16), the flow of the logical algorithm being highlighted in the figure below:




The originality of the ARDRA and ARDRA-S algorithms lies in the fact that they are applicable and adapted to current practice and are dynamic algorithms, in the sense that they ask the health professional to repeat the test after re-evaluating the SPC of the pharmaceutical products. For the definitive confirmation of AR, ARDRA and ARDRA-S direct the health professional to the Naranjo scale and the WHO scale.

Subchapter 5.2.3 presents the ARDRA algoritm, which contains the following questions:

1. Since the beginning of this treatment, have you ever been sick or have you had any pain or been sick? if "YES" the questionnaire is continued, if "NO", it is stopped.

2. Is the patient currently taking medication?

3. Does the patient's initial pathology explain the present symptoms?

4. Did the symptoms/signs appear before the administration of one or more medications?

5. Can the symptoms/signs be explained by the adverse reactions mentioned in the SPC?

6. Are there any symptoms other than those mentioned in the SPC that indicate another pathology?

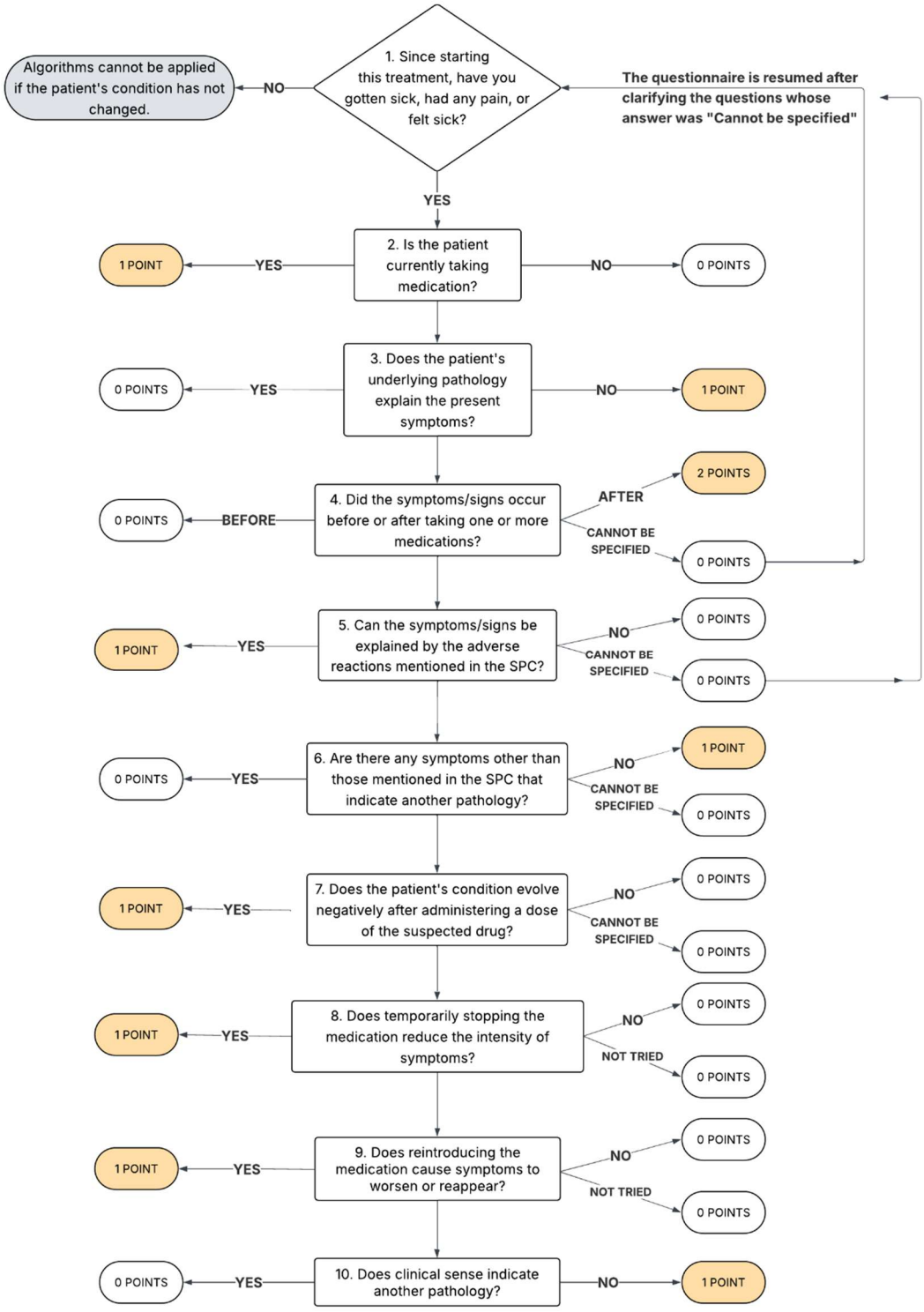
7. Does the patient's condition deteriorate after taking a dose of the suspected drug?

8. Does temporarily stopping the drug reduce the intensity of the symptoms?

9. Does reintroducing the drug cause the symptoms to worsen or reappear?

10. Does clinical sense indicate another pathology?

The logical algorithm and scores obtained by applying **ARDRA** are shown in the image below:



Subchapter 5.2.5 presents ARDRA-S, which contains the following questions:

1. Since the beginning of this treatment, have you become ill or have you had any pain or been sick? If "YES" the questionnaire continues, if "NO" it stops.

2. Did the symptoms/signs appear before the administration of one or more drugs?

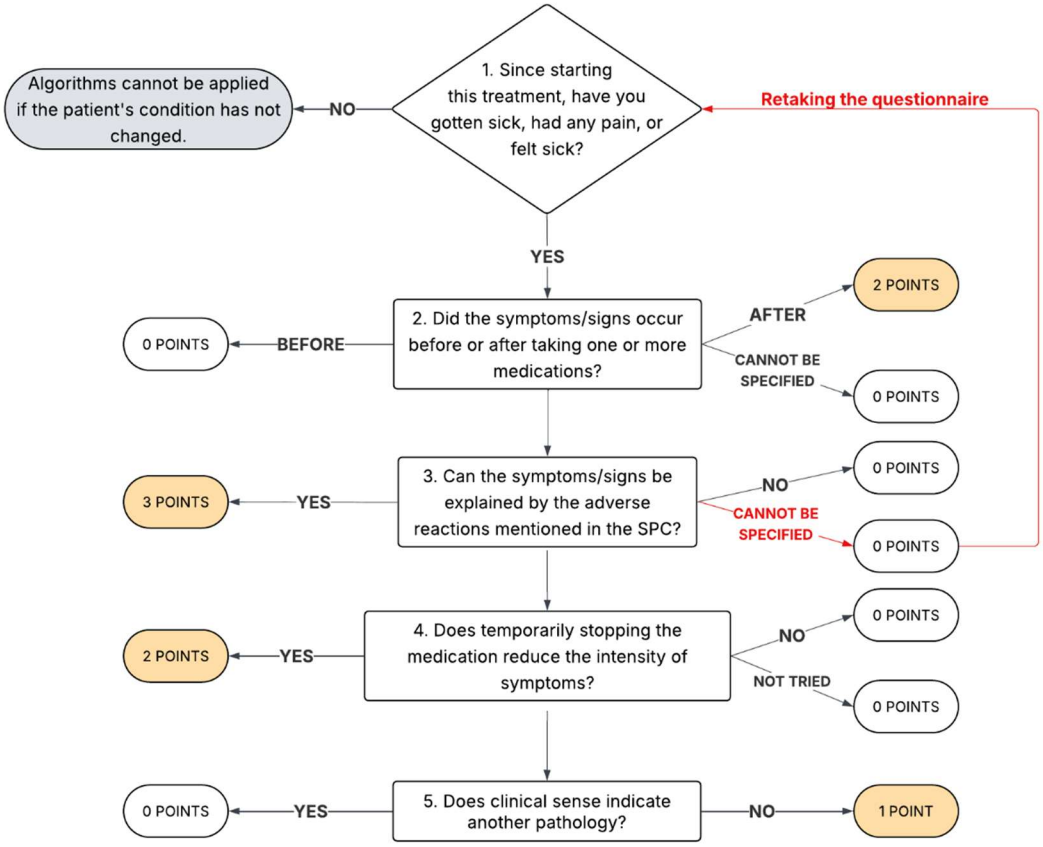
On the ARDRA.ro website, the score is given according to the algorithm.

3. Can the symptoms/signs be explained by the adverse reactions mentioned in the SPC?

4. Does the temporary cessation of the drug have the effect of decreasing the intensity of the symptoms?

5. Does clinical sense indicate another pathology?

The logical algorithm and the scores obtained by applying **ARDRA-S** are shown in the image below:



# 6. Electronic rapid method for testing susceptibility to antimicrobials or antifungals. R-METSA

In this chapter we have described the method and apparatus that were the subject of the patent application filed with OSIM with the number A/00199 of 02.04.2026. R-METSA is an invention, a functional prototype in the development-optimization phase, The Method requires comparative validation with standardized methods.

## Detailed exposition of the invention

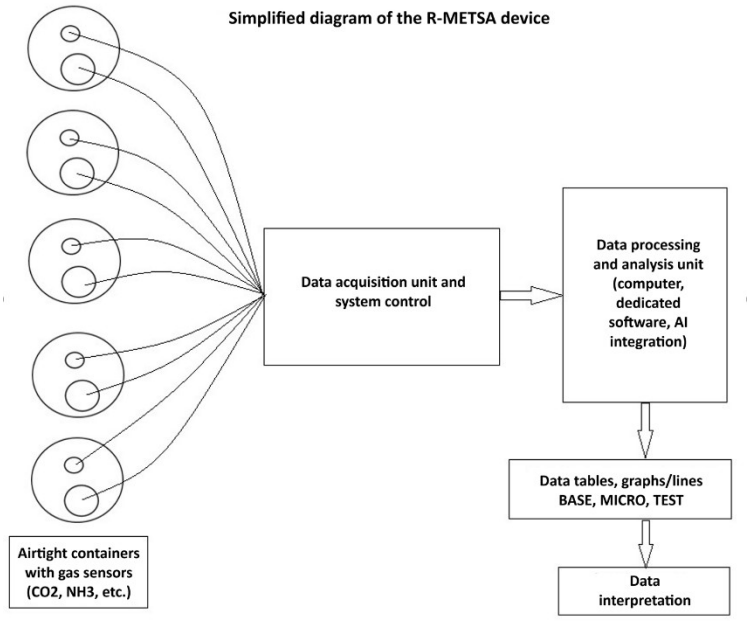
### 6.1.1. The principle of determination

Bacteria and/or fungi seeded on the culture medium carry out biological activity, including before the logging phase. The activity of microorganisms is more intense after the lag phase. They live and multiply by consuming the substrate and generate metabolites that they release into the environment. As a result of the biological activity in the culture medium, changes in the concentration of the substances that feed the bacteria will occur (decrease in the concentration of starch, glucose, proteins, etc.), changes in pH, pCO2, pNH3, pCH4, pH2, pH2S and other measurable changes.

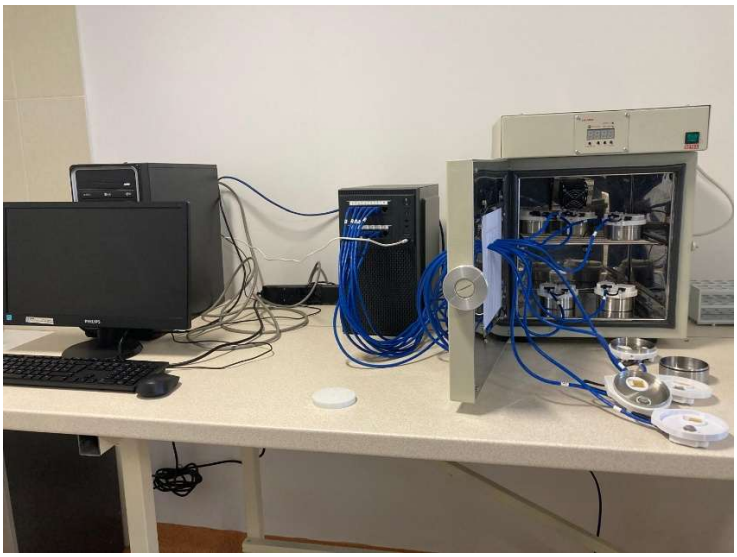
- A culture medium seeded with a biological sample without bacteria or fungi will maintain its constant characteristics (**it follows that no infection is present**).
- A culture medium seeded with a biological sample with a bacterium or fungus feeding on the culture medium will change its characteristics (pH, NH3, pCO2, concentration of substances) at the latest after the lag phase of the bacterium (**it follows that infection is present**). NOTE1: The method is not intended for slow-growing microorganisms (see Mycobacterium tuberculosis) that require a very long determination time.
- NOTE2: The method may give false positive results, i.e. confirm the presence of infection, when biological samples considered theoretically sterile are contaminated with commensal flora or the cultivation and selection procedure for biological samples has not been done accurately.
- A culture medium seeded with a biological sample with a bacterium or fungus that feeds on the culture medium **but into which an effective antimicrobial or antifungal has been brought** after the lag phase of the bacterium **will NOT** change its characteristics.

(**it follows that the antimicrobial is effective in fighting infection), i.e. the bacterium or fungus involved is sensitive to the antimicrobial/antifungal tested.**

- A culture medium seeded with a biological sample containing a bacterium or fungus that feeds on the culture medium **but into which an ineffective antimicrobial has been introduced** will change its characteristics. (**It follows that the antimicrobial is ineffective in fighting infection**) **at the latest** after the lag phase of the bacterium or fungus, i.e. the bacterium or fungus is resistant to the antibiotic/antifungal tested.
  The simplified diagram of the R-METSA is illustrated below:

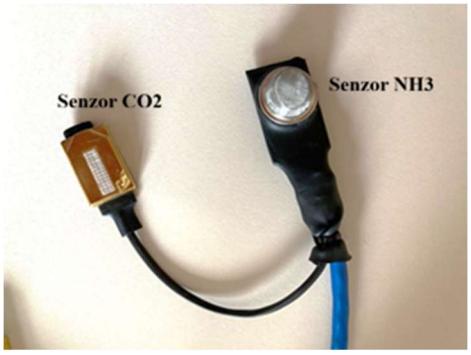


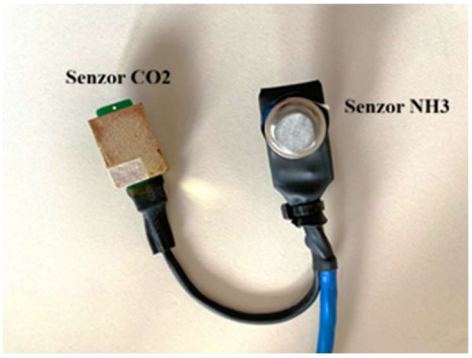

An image of the device as well as the sensor containers is shown below:



Computer, data acquisition unit, incubator with containers in different stages of sensor assembly can be seen in the images below:

Incubator with containers to which sensors have been attached




Sensors used: CO2 (Model: MH-Z19B and Model MH-Z19C v. www.winsen-sensor.com) and (MQ-137) v. hwsenzor.com

**Antimicrobial susceptibility testing - Stages of analysis**

The analysis is carried out by preparing three types of containers: "Base Container", "Micro Container" and "Test Containers": "Base Container" contains the culture medium and atmospheric air; The 'Micro Container' contains the culture medium, atmospheric air and the sample to be analysed; The 'Test Containers' contain the culture medium, atmospheric air, the biological sample to be analysed and the antimicrobials to be tested, one antimicrobial in each container.

In all tests, a suitable culture medium must be selected. The containers are incubated under controlled conditions at 37°C.

Measurable parameters in the culture medium, including at least CO2 and NH3 production, shall be monitored. The results obtained for the 'Test' lines are compared with both the 'Micro' and the 'Baseline' reference line, with only parameters showing changes to the 'Micro' line being evaluated. For example, if only the graph associated with the CO2 sensor is changed to the "Micro" line, then only the graphs related to this sensor will be compared, and the other records will not be taken into account.

**Interpretation of the results**

**Antimicrobial susceptibility testing**

The presence of microbial activity is determined on the basis of changes in the monitored parameters in the container containing only the biological sample and the culture medium. The efficacy of antimicrobials is determined on the basis of the presence or absence of parameter changes in the containers containing the culture medium, the sample analysed and the substances tested.

If the recorded values and graphs for the modified parameter in the 'Micro' line are closer to the baseline, it follows that the bacterium or fungus is sensitive to the antimicrobial tested. If the values recorded for the modified parameter in the 'Micro' line are closer to the 'Micro' line, it follows that the bacterium or fungus is not sensitive to the antimicrobial tested. If the slope of the recorded right is equal to '0' or as close as possible to '0', the antimicrobial used is considered effective. Such a slope indicates the cessation of metabolic activity of the microorganism, and gas concentrations remain stationary. If the antimicrobial is ineffective, the test line remains similar and close to the 'Micro' line, and the slope of the right is comparable to the slope of the 'Micro' line.

**Detection of microbial metabolic activity.** The method makes it possible to suggest the presence of infection by using high-sensitivity gas sensors and electronically interpreting the obtained data.

**Estimation of the minimum inhibitory concentration (MIC).**

An important objective of R-METSA was the estimation of the minimum inhibitory concentration (MIC). To this end, at the time of evaluation, the tested microorganisms are exposed to different concentrations of antibiotic or antifungal, and the metabolic response is

electronically monitored. The CMI corresponds to the lowest concentration at which the recorded signal remains close to the BASELINE and has a slope of "0", suggesting inhibition of microbial growth.

In test vessels containing the culture medium inoculated with bacteria or fungi, the antimicrobial is introduced in progressively decreasing concentrations. The MIC is estimated to be the lowest concentration for which the corresponding test line remains close to baseline.

The data analysis in R-METSA is illustrated by the tables and graphs below:

| Data | Ora | Ora (min) | G0S0 | G0S1 | G0S2 | G0S3 | G0S4 | G0S5 | G0S6 | G0S7 | G0S8 | G0S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2025-12-11 | 17:23:33 | 62613.00 | 434.74 | 433.17 | 430.25 | 431.59 | 436.85 | 441.31 | 435.99 | 439.1 | 440.05 | 445.2 |
| 2025-12-11 | 17:24:03 | 62643.00 | 439.35 | 436.16 | 431.32 | 432.65 | 442.93 | 453.46 | 438 | 446.92 | 450.43 | 463 |
| 2025-12-11 | 17:24:33 | 62673.00 | 444.7 | 439.83 | 433.78 | 434.22 | 448.17 | 466.7 | 438.23 | 451.67 | 460.69 | 478.4 |
| 2025-12-11 | 17:25:03 | 62703.00 | 450.56 | 443.75 | 437.44 | 434.44 | 451.86 | 478.38 | 436.75 | 455.52 | 467.68 | 491.2 |
| 2025-12-11 | 17:25:33 | 62733.00 | 455.55 | 447.32 | 441.07 | 433.8 | 455.01 | 485.62 | 434.36 | 458.92 | 472.86 | 493.2 |
| 2025-12-11 | 17:26:03 | 62763.00 | 460.49 | 450.87 | 443.92 | 432.87 | 457.89 | 491.03 | 432.03 | 461.88 | 477.38 | 491.6 |
| 2025-12-11 | 17:26:34 | 62794.00 | 465.49 | 454.3 | 444.61 | 431.78 | 460.66 | 494.99 | 431.28 | 464.81 | 481.1 | 490 |
| 2025-12-11 | 17:27:03 | 62823.00 | 470.65 | 457.74 | 444.19 | 430.68 | 463.54 | 498.01 | 431.1 | 467.57 | 484.05 | 490 |
| 2025-12-11 | 17:27:33 | 62853.00 | 476.07 | 461.25 | 443.08 | 429.92 | 466.62 | 500.68 | 431.43 | 470.06 | 486.45 | 490 |
| 2025-12-11 | 17:28:03 | 62883.00 | 481.6 | 464.66 | 442.32 | 429.56 | 469.76 | 502.81 | 431.84 | 472.17 | 488.55 | 490 |
| 2025-12-11 | 17:28:33 | 62913.00 | 486.93 | 468.06 | 441.96 | 429.43 | 472.71 | 504.72 | 432.13 | 474.08 | 490.52 | 490 |
| 2025-12-11 | 17:29:03 | 62943.00 | 491.71 | 471.39 | 441.82 | 429.35 | 475.67 | 506.47 | 432.36 | 475.91 | 492.36 | 490 |
| 2025-12-11 | 17:29:33 | 62973.00 | 495.97 | 474.7 | 441.91 | 429.3 | 478.68 | 508.18 | 432.56 | 477.65 | 494.19 | 490.2 |
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| 2025-12-11 | 17:30:33 | 63033.00 | 503.15 | 481.25 | 442.94 | 429.35 | 484.19 | 511.46 | 432.96 | 481.25 | 497.93 | 494.4 |
| 2025-12-11 | 17:31:03 | 63063.00 | 506.02 | 484.32 | 443.65 | 429.32 | 486.74 | 512.98 | 433.25 | 483.01 | 499.91 | 498.4 |
| 2025-12-11 | 17:31:33 | 63093.00 | 508.53 | 487.3 | 444.35 | 429.37 | 489.25 | 514.39 | 433.62 | 484.72 | 501.93 | 503.8 |
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| 2025-12-11 | 17:39:34 | 63574.00 | 527.08 | 503.9 | 447.76 | 430.62 | 518.33 | 528.26 | 442.11 | 500.21 | 533.74 | 599.2 |
| 2025-12-11 | 17:40:04 | 63604.00 | 527.23 | 503.9 | 448.14 | 430.72 | 520.03 | 528.78 | 442.67 | 500.67 | 535.38 | 605.2 |
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| 2025-12-11 | 17:41:04 | 63664.00 | 527.4 | 503.9 | 448.99 | 430.96 | 522.95 | 529.87 | 443.64 | 501.41 | 538.54 | 616.2 |
| 2025-12-11 | 17:41:34 | 63694.00 | 527.33 | 503.9 | 449.33 | 431.04 | 524.2 | 530.35 | 444.11 | 501.74 | 540.06 | 620 |
| 2025-12-11 | 17:42:04 | 63724.00 | 527.16 | 503.9 | 449.72 | 431.17 | 525.42 | 530.8 | 444.56 | 502.08 | 541.52 | 623 |
| 2025-12-11 | 17:42:34 | 63754.00 | 527.01 | 503.9 | 450.13 | 431.32 | 526.65 | 531.24 | 445.03 | 502.4 | 543.02 | 626.2 |
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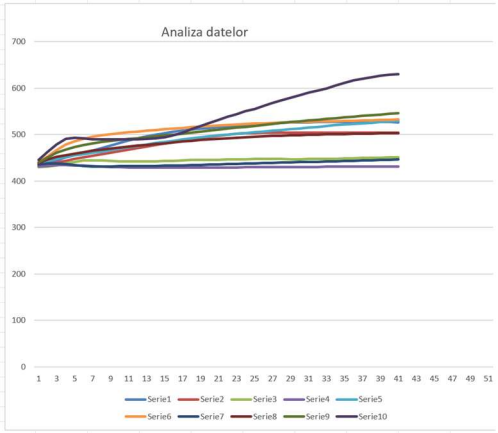


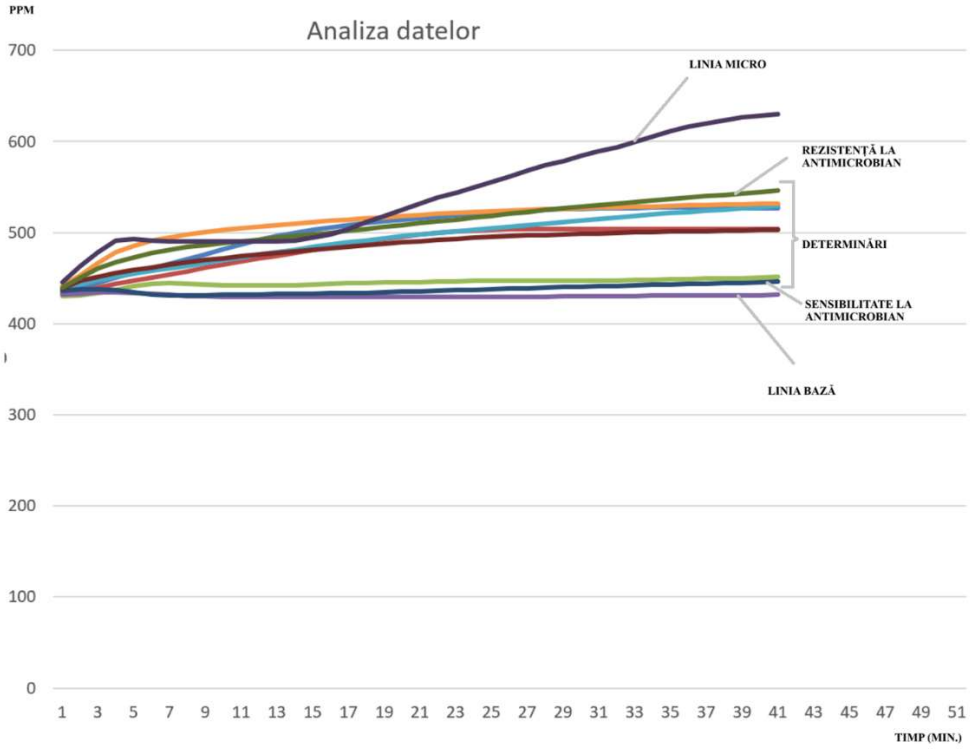

# 7. Conclusions and personal contributions

Chapter 7 summarizes his personal conclusions and contributions.

## Conclusions

The research within the doctoral thesis brought new information/knowledge regarding the **pharmaceutical service**, **the research of side effects** and factors influencing uric acid levels, confirmed and strengthened the role of the pharmacist as an essential filter in the health system. Also, the developments of the "**Pharmacist's Recommendation Integrated Information System",** of the **Rapid Algorithms for Detecting Adverse Reactions, "ARDRA" and ARDRA-S** and of the www.ardra.ro website, of the "**Rapid Method for Antimicrobial Sensitivity Testing R-METSA" method and apparatus** represent modern and original means involved in the pharmaceutical act and with an impact on patients' health.

## Future research directions

**The pharmaceutical service** , which is still in its infancy in Romania, offers extensive possibilities for research, but also for improving the health of patients.

**The evaluation of iatrogenic hyperuricemia** is also to be studied through longitudinal studies.

**The Pharmacist's Recommendation Integrated Information System,** implemented for the time being in few pharmacies, will be promoted and implemented so as to become a standard of practice in the relationship with the patient. The development of the data acquisition server is the natural step for this project. In this way, the "Pharmacist's Recommendation" could become a valuable research tool through the information collected.

**ARDRA, ARDRA-S** and the www.ardra.ro website will be enhanced with AI algorithms that document possible side effects in real time, analyzing the list of drugs used, the patient's known diagnoses, the accused symptomatology and the RA mentions for each drug administered. Another desired step is the creation of versions in international languages.

As far as **R-METSA** is concerned, the concept of the device was developed through the "try and error" technique try, fail, find, modify, try again. The evolution of the device and the method are particularly promising and challenging.

There are still a number of problems to be solved and directions for the study and development of the device and method:

- Making airtight containers containing the right growing medium, with a standard volume, but also with a standard concentration of atmospheric gases.
- Developing/identifying less fragile sensors or protecting them.
- Equipping the device with a robotic arm and QR code readers so that the handling of containers, antimicrobials and samples is done without risk of contamination to personnel or samples.
- Placing each pair of sensors at a distance from samples in connected tight enclosures during the performance of readings through flexible tubes with the samples to be analyzed, and the gas flow to be driven by peristaltic pumps. The connection of the flexible tubes to the samples to be analyzed should be done with robotic arms.

Development of software with AI algorithms that analyze readings and learn patterns.

All these represent modern approaches within the pharmaceutical act, with a significant impact on patients' health.

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