

Supplementary material
Survey (translated from Danish to English)

F	Questions for both professions (physicians and nurses)
L	Questions for physicians only

<p>F1. Are you a nurse or a physician?</p> <p><input type="checkbox"/> Nurse</p> <p><input type="checkbox"/> Physician</p>	<p>F2. Where is your primary place of employment?</p> <p><input type="checkbox"/> Capital Region of Denmark</p> <p><input type="checkbox"/> Region Zealand</p> <p><input type="checkbox"/> Region of Southern Denmark</p> <p><input type="checkbox"/> Central Denmark Region</p> <p><input type="checkbox"/> North Denmark Region</p>
<p>F3. In which field are you employed?</p> <p><input type="checkbox"/> Emergency Department</p> <p><input type="checkbox"/> General Practice</p> <p><input type="checkbox"/> Anesthesiology/Recovery Room</p> <p><input type="checkbox"/> Intensive Care</p> <p><input type="checkbox"/> Surgical</p> <p><input type="checkbox"/> Medical (e.g., hematology, oncology, endocrinology)</p> <p><input type="checkbox"/> Primary sector (e.g., home based nursing care, nursing homes, rehabilitation)</p> <p><input type="checkbox"/> Psychiatric</p> <p><input type="checkbox"/> Pediatric</p>	<p>F4. Specify ONLY if you are employed in one of the following departments (if not, click "Next"):</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p> <p><input type="checkbox"/> [REDACTED]</p>
<p>F5. Indicate the number of years since completing your medical or nursing education:</p> <p><input type="checkbox"/> Less than 1 year <input type="checkbox"/> 1 – 5 years</p> <p><input type="checkbox"/> 6 – 10 years <input type="checkbox"/> 10 years</p>	<p>F6. In your clinical practice, do you experience any problems with penicillin allergy registred in the electronic patient record, that affect patient treatment?</p> <p><input type="checkbox"/> To a high degree <input type="checkbox"/> To some degree</p> <p><input type="checkbox"/> To a lesser degree <input type="checkbox"/> Not at all</p>
<p>F7. Which problems do you experience in in the treatment?</p> <p>(1) <input type="checkbox"/> The patient cannot receive optimal treatment</p> <p>(2) <input type="checkbox"/> Delayed start of treatment due to additional time used to identify alternative treatment options</p> <p>(3) <input type="checkbox"/> Increased treatment time and/or inpatient length of stay</p> <p>(4) <input type="checkbox"/> The patient develops more side effects</p> <p>(5) <input type="checkbox"/> Other, specify _____</p>	<p>F8. What do you believe to be possible consequences of having an unconfirmed penicillin allergy label, registrered in the electronic patient journal?</p> <p><input type="checkbox"/> Increased risk of multiresistant bacterial infections</p> <p><input type="checkbox"/> Increased risk of Clostridioides Difficile infection</p> <p><input type="checkbox"/> Increased costs for alternative antibiotics</p> <p><input type="checkbox"/> Poorer treatment results</p> <p><input type="checkbox"/> Longer hospital stay</p> <p><input type="checkbox"/> Higher mortality rate</p> <p><input type="checkbox"/> Higher hospital readmission rates</p> <p><input type="checkbox"/> I do not believe there are any negative consequences</p>

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<p>F9. Have you experienced patients developing allergic symptoms in connection with the administration of penicillin preparations?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know</p>	<p>F10. What allergic symptoms were present?</p> <p><input type="checkbox"/> Skin rash <input type="checkbox"/> Itching <input type="checkbox"/> Swelling <input type="checkbox"/> Anaphylaxis (life-threatening reaction with or without rash) (5) <input type="checkbox"/> Other, specify _____</p>
<p>F11. Do you work with Sundhedsplatformen (EPIC)?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>F12. Do you read the comment field in the allergy section of Sundhedsplatformen? When you click on the allergy field, a comment field opens.</p> <p><input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Never</p>
<p>F13. Is there automatic exchange of data on allergy status between primary sector and hospitals?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know</p>	<p>F14. Do you believe it is part of your job description to assess/reassess a patient's allergy status upon admission or consultation?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know</p>
<p>F15. Have you ever created a penicillin allergy entry in the electronic medical record?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>F16. Do you experience problems in the electronic medical record when registering penicillin allergy?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>
<p>F17. Please indicate the most significant problems (choose a maximum of two):</p> <p><input type="checkbox"/> There are no categories that match my assessment <input type="checkbox"/> The allergy field is confusing and/or illogically structured <input type="checkbox"/> I haven't had time to familiarize myself with the functionality of the allergy field <input type="checkbox"/> I haven't received training on how to register an allergy <input type="checkbox"/> Other, please specify _____</p>	<p>F18. I would register the label "penicillin allergy" in the medical record if:</p> <p><input type="checkbox"/> The patient develops skin rash after multiple doses of penicillin <input type="checkbox"/> The patient has close family members with penicillin allergy <input type="checkbox"/> The patient claims to have penicillin allergy, and the medical history is uncertain/incomplete <input type="checkbox"/> The patient experiences mild nausea/vomiting/diarrhea/abdominal pain/heartburn after administration of penicillin <input type="checkbox"/> The patient experiences urticaria/angioedema/respiratory problems/drop in blood pressure within 2 hours after the first dose of penicillin <input type="checkbox"/> Other, please specify _____</p>

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L: You are now being presented with three cases. Please select the appropriate option based on your preferred course of action.

L19. CASE 1. A 71-year-old woman presents with symptoms of a urinary tract infection. She was treated with penicillin for tonsillitis during her childhood. She developed a rash afterwards and has not taken penicillin since then. The electronic patient journal indicates/says "penicillin allergy." The patient has experienced repeated urinary tract infections and has been treated with alternative antibiotics, with poor effectiveness. What do you do?

L20. CASE 2. A 55-year-old man is admitted with suspected pneumonia. "penicillin allergy" is registered in the electronic patient record due to urticaria (hives) and itching occurring less than two hours after the first dose of penicillin during treatment last year. What do you do?

L21. CASE 3. A 62-year-old woman with a postoperative surgical wound infection in the groin. Response from wound grafting indicates that bacteria are sensitive to penicillin and other broad-spectrum antibiotic agents. The patient is registered with "penicillin allergy" due to nausea and mild stomach pain. What do you do?

I prescribe an alternative to penicillin.
 I prescribe an alternative to penicillin and refer the patient to an allergy clinic for evaluation of penicillin allergy.
 I prescribe penicillin and administer the first dose under close observation.
 I assess that the patient does not have an allergy and prescribe a penicillin course (if the patient agrees).

F22. When assessing/reassessing whether the patient may be allergic to penicillin, how often do you ask the patient about the following?

Name of the medication?

	Always	Sometimes	Never
Name of the medication?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How long ago did the reaction occur?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
What specific symptoms did the patient experience?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How long after administration of the penicillin preparation did the reaction occur?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<p>L23. Have you ever removed the label "penicillin allergy" from a patient whom you assessed as not having an allergy?</p> <p> <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Never been in such situation </p>	<p>L24. What was the reason for assessing that the patient did not have a penicillin allergy?</p> <p> <input type="checkbox"/> The label "penicillin allergy" was created due to symptoms as fatigue/dizziness/vasovagal reaction/headache <input type="checkbox"/> The patient developed a reaction before starting penicillin treatment <input type="checkbox"/> The label "Penicillin" was created because the patient has a close family member with penicillin allergy <input type="checkbox"/> The patient mistakenly received the same medication despite the label "penicillin allergy" and tolerated it subsequently <input type="checkbox"/> The label "penicillin allergy" was created due to mild nausea/vomiting/diarrhea/stomach pain/heartburn <input type="checkbox"/> I found reliable evidence that the patient tolerated the same medication after the penicillin label was registered <input type="checkbox"/> Other, specify _____ </p>
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<p>L25. Have you ever avoided to remove a penicillin allergy label from the electronic medical record, even though you believed the patient was not allergic?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Never been in such situation</p>	<p>L26. What were the reasons for not removing the label "penicillin allergy"?</p> <p><input type="checkbox"/> There were language barriers/communicative/cognitive issues with the patient <input type="checkbox"/> The patient was apprehensive about changing their allergy status, despite my explanation that the allergy was not real <input type="checkbox"/> I don't believe it's my responsibility to change the allergy status <input type="checkbox"/> I didn't have time/I forgot <input type="checkbox"/> There could still be a risk that the patient actually had a penicillin allergy, and therefore I didn't want to change the allergy status <input type="checkbox"/> I don't believe I know enough about allergies to remove the label "penicillin allergy" <input type="checkbox"/> It's too difficult/ unmanageable in the electronic medical record <input type="checkbox"/> Other, please specify _____</p>
<p>F27. To what degree do you trust that the allergy is real when you see a penicillin allergy label registered in the electronic medical record?</p> <p><input type="checkbox"/> To a high degree <input type="checkbox"/> To some degree <input type="checkbox"/> To a lesser degree <input type="checkbox"/> Not at all</p>	<p>F28. Please indicate why you do not fully trust a penicillin allergy label registered in the electronic medical record?</p> <p>_____ _____ _____ _____</p>
<p>F29. Have you ever prescribed and/or administered penicillin to a patient with a penicillin allergy label, registered in the electronic patient record?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>F30. What were the reasons for prescribing/administering penicillin?</p> <p><input type="checkbox"/> It was an unintended event <input type="checkbox"/> I assessed that the patient did not have a penicillin allergy <input type="checkbox"/> There were no other treatment options available <input type="checkbox"/> Other, please specify _____</p>
<p>F31. Do you have anything you would like to add to the topic of penicillin allergy?</p> <p>_____ _____ _____ _____</p>	<p>F32. May we contact you for a potential follow-up interview?</p> <p><input type="checkbox"/> Yes, please (provide email) _____ <input type="checkbox"/> No, thank you</p>
<p>Thank you for your response!</p>	

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Thematic analysis inspired by systematic text condensation (Malterud 2012)

Example of audit trail (page 1) and presentation of steps in the thematic analysis (page 2-4)

Example of audit trail

Examples of meaningful units	Content	Preliminary themes	Theme
<p><i>"Out of fear of overlooking something that could be an allergy, we over-register in the allergy section."</i></p> <p><i>"I have experienced that some doctors, in specific cases, are not entirely convinced that the patient actually has an allergy. But they still fill out the allergy form, just to be on the safe side."</i></p> <p><i>"Unfortunately, the experience is that the majority have had allergy registered based on an uncertain reaction to an unknown antibiotic (patients often mistakenly confuse other antibiotics with penicillin). Often, it is a reaction from many years ago, often a reaction that the patient does not remember but has been told by their mother... etc."</i></p> <p><i>"Many people tend to register penicillin allergy labels even with very little suspicion. Just to be on the safe side."</i></p>	<p>Describing how there exists a registration practice where uncertainty and fear can contribute to over-registration of allergy.</p> <p>There is a registration practice where uncertainty and fear can lead to the over-registration of allergy.</p> <p>Childhood reactions with limited details can be the basis entering an allergy in the EMR (it is assumed that any potential allergy is impossible to determine, hence the need for registration as a precautionary measure).</p> <p>Registrations are made based on very little suspicion or a low threshold, just to be on the safe side.</p>	<p>Allergy is registered "just in case".</p> <p>A registration of allergy relies on patient-reported data.</p> <p>Penicillin allergy label is registered based on childhood reactions.</p> <p>Uncertain medical histories (when in doubt, one registers).</p> <p>The threshold for indicating an allergy is low.</p>	<p>A precautionary principle.</p>

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Example of audit trail (page 1) and presentation of steps in the thematic analysis (page 2-4)

Step 1: Total impression and pre-analysis	
<p>Carried out separately by author A and author B. Responses from open-ended questions were intuitively analyzed within each subject group and each question</p> <p>Question: “Please indicate why you do not fully trust a penicillin allergy label registered in the electronic medical record?”</p>	<p><u>Author A: Themes</u></p> <p>Physicians: <i>Lack of elaboration of symptoms/lack of questioning of the pt; Placed too much weight on the patient's statement; Lack of allergy testing; Penicillin allergy label registration is due to common side effects; Rash is a common side effect to some drugs; Penicillin allergy label registration due to underlying disease; In multimedicated patients, penicillin is often blamed for the reaction; In the case of penicillin in combination with other antibiotics, penicillin is blamed; Uncertain medical history; Difficult to ask about penicillin allergy in acute cases; Over-labelling; In case of challenge/or at medication error the patient nevertheless tolerated penicillin; Lack of reassessment; The allergy label field is a trash field; Lack of consensus about what the allergy label is/when to register penicillin allergy label; Lack of knowledge about when something is an allergy; Junior doctors over-register/ do not reassess the penicillin allergy label due to lack of experience; Lack of guidelines; Challenges with IT; It's easy to forget to register a penicillin allergy label; It is rarely type 1 /immediate reaction; Pt. do not remember reason of the penicillin allergy label; Pts. mix together antibiotics and penicillin.</i></p> <p>Nurses: <i>Penicillin allergy label registration is due to common side effects; There is an over-registration of penicillin allergy labels; Assessment of the penicillin allergy label on the basis of uncertain anamnesis; Allergy testing; Placed too much weight on the patient's statement; The penicillin allergy label is not re-evaluated; There is an under-registration of penicillin allergy labels; Junior doctors over-register/does not reassess penicillin allergy labels due to lack of experience; Lack of elaboration of symptoms and onset; Lack of inquiry of pt; Penicillin is blamed; Pt. cannot remember reason for the penicillin allergy label; Anaphylaxis rarely develops; Has learned that it was erroneous; Education about penicillin allergy; True allergy is rare; In case of challenge/at medication error pt. has nevertheless tolerated penicillin.</i></p> <p><u>Author B: Themes</u></p> <p>Physicians: <i>Incomplete medical history; Uncritical attitude/symptoms are not asked into; Different definitions and perception of the penicillin allergy label (allergy vs. side effect); Knowledge gap; Lack of support from the IT system; The patient's knowledge; Failure to update penicillin allergy label status; Threshold to register a penicillin allergy label is low/over-registration/just in case; Uncertain anamnesis/doubts about allergies; Acute situations as a barrier to reassessment; Experience that a penicillin allergy label often is not real; Do not trust allergies before investigation/tests.</i></p> <p>Nurses: <i>Do not ask into/register penicillin allergy label without complete history; penicillin allergy label registered on the basis of reactions in childhood/relic of the past and has not been followed up on; The penicillin allergy label field is incompletely filled in - affects trust in status and possibility of reassessment; penicillin allergy label relies exclusively on patient-provided data/information; Perception of penicillin allergy label (allergy vs side effects + “it's just a small skin rash”); penicillin allergy label is registered just in case/over-registration.</i></p> <p><u>Author A: Themes</u></p>
<p>Question:</p>	<p><u>Author A: Themes</u></p>

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Example of audit trail (page 1) and presentation of steps in the thematic analysis (page 2-4)

<p>“Do you have anything you would like to add to the topic of penicillin allergy?”</p>	<p>Physicians: Allergy investigation; penicillin allergy labels are not being updated; Urgent situation prevents decision making of penicillin allergy label; A wish of a database that is available both in the primary sector and in hospitals, through the Shared Medication Record; Pt. has no recollection of allergy, penicillin allergy label registration despite poor medical history; Problems with penicillin allergy label registration in the EMR; Pts mix together penicillin and antibiotics; Reluctance to remove penicillin allergy label without investigation; Wish to state in the EMR that the pt. has had relevant allergy investigation performed; Penicillin allergy is rare; Combination of certain types of antibiotics in children causes rash in viral infections, which is misinterpreted as allergy; Request for guidelines regarding the assessment of penicillin allergy label; There are too many registered with an incorrect penicillin allergy label; Lack of consensus among clinicians about when something is assessed as penicillin allergy label; The societal perspective – multiresistance, but does not experience the problem in treatment; penicillin allergy label and negative consequences for treatment.</p> <p>Nurses: Considerations about insufficient medical history; Side effects are misinterpreted as allergies by patients and staff; Takes thorough anamnesis in relation to penicillin allergy label in connection with admission and initiation of antibiotics; Does not relate to whether the allergy is correct or not; Considerations about administering doctor-prescribed medication the patient has a registered label to; Considerations regarding investigation at Allergy Clinic when documenting penicillin allergy label; Over-registration of penicillin allergy label due to fear of anaphylaxis; New IT system complicates the registration of penicillin allergy label; Request of decision support; Lack of knowledge and a common approach on registration of the penicillin allergy label; Penicillin allergy label field is not filled out.</p> <p><u>Author B: Themes</u></p> <p>Physicians: Failure to take a critical stand when registering/assessing and reassessing the penicillin allergy label; The IT system's lack of support; Patient knowledge; Investigation and low capacity; Problems in the acute patient situations.</p> <p>Nurses: It is not the nurse's responsibility that the penicillin allergy label is updated; Collaboration between nurses and doctors in relation to penicillin allergy label; Do not experience incorrect penicillin status or patients with penicillin allergy as a problem directly in daily work; Lack of critical judgement/imprecise and incomplete anamnesis of the penicillin allergy label; Patients' perception; Benefits of testing/provocation for suspected allergies; The IT system's lack of support in relation to penicillin allergy label.</p>
<p>Intuitive themes from pre-analysis formed the basis for 12 themes. Some themes repeated within both subject groups and others only presented itself in one subject group. The themes are presented divided for each question and subject group.</p>	<p><u>”Trust”:</u> Physicians + Nurses</p> <ol style="list-style-type: none"> 1. There are not asked into symptoms 2. Registration of penicillin allergy label with incomplete anamnesis 3. Penicillin allergy label is registered exclusively based on patient-informed data (relic of the past) 4. Perception of penicillin allergy label (allergy vs. side effects) 5. A precautionary principle (over-labeling) 6. Lack of allergological evaluation <p>Only physicians:</p> <ol style="list-style-type: none"> 7. Lack of guidelines for when to register a penicillin allergy label 8. Lack of support in IT-system 9. Junior doctors recording the anamnesis <p><u>”Additional comments to the topic”:</u> Physicians + Nurses</p>

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	<p>4. Perception of penicillin allergy label (allergy vs. side effects) 6. Lack of allergological evaluation 8. Lack of support in IT-system <u>Only physicians:</u> 2. Registration of penicillin allergy label with incomplete anamnesis 3. Penicillin allergy label is registered exclusively based on patient-informed data (no recollection or knowledge of) 7. Lack of guidelines for when to register penicillin allergy labels 12. Lack of re-assessment of penicillin allergy labels <u>Only nurses:</u> 10. No problems in daily practice 11. Overruling of penicillin allergy label after physician assessment</p>
Step 2: Identifying and sorting meaning units	
<p>All comments (191 from physicians and 106 from nurses) from the two open answer questions and the six answer categories "other" were printed out, still divided by group. The 12 themes were used as a framework for sorting. Remaining themes were set a side.</p>	<p>The following themes were eliminated: <u>Both physicians and nurses:</u> <i>Lack of guidelines for when to register a penicillin allergy label.</i> <u>Physicians:</u> <i>Lack of IT support; Junior doctors record anamnesis</i> <u>Nurses:</u> <i>Patient knowledge (Pt. denies penicillin allergy label/Does not remember penicillin allergy label); No problems in daily practice.</i> A total of 7 themes remained</p>
Step 3: Condensation	
<p>Content of meaningful units, relevance, and precision under each of the 7 themes were discussed. Names of themes were clarified and themes which after analysis of content were found to belong to other themes, were merged.</p>	<p>Following themes were merged: <i>Penicillin allergy label is registered exclusively based on patient-informed data (limited memory + knowledge (relic of the past/childhood) → precautionary principle.</i> <i>There are not asked into symptoms → Registration of penicillin allergy label with incomplete anamnesis (poor anamnesis).</i> 5 final themes: 1. Precautionary principle (Relic of the past/Childhood; Uncertain anamnesis) 2. Insufficient understanding of when and why an allergy label should be registered (allergy vs. side effects). 3. Poor documentation of patient medical history 4. Lack of re-evaluation of allergy labels 5. Lack of allergological evaluation</p>
Step 4: Synthesizing	
<p>Finally, all the comments were read again, and themes were discussed in relation to the original material.</p>	<p>No new themes were found/identified.</p>