



SHAPES

Smart and **H**ealthy **A**geing
through **P**eople **E**ngaging in supportive **S**ystems

D4.6 – SHAPES Interoperability Reference Testing Environment

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Table 1 Revision History

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0.5	26/10/2021	George Bogdos (FINT), Gorka Epelde Unanue (VICOM)	Peer review of the report
1.0	27/10/2021	Thomas Tsouskos (GNO), Kostas Karkaletsis (GNO), Nikos Mpampamis (GNO), Alexander Berler (GNO)	Final version

Table of Acronyms and Abbreviations

Table 2 Acronyms and Abbreviations

Acronym	Full Term
Digital Solution	DS
Fast Healthcare Interoperability Resources	FHIR
JavaScript Object Notation	JSON
Extensible Markup Language	XML

Keywords

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Interoperability Reference Testing Environment, FHIR

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Executive Summary

This report accompanies the D4.6 SHAPES Interoperability Reference Testing Environment. D4.6 is categorised as “OTHER” and the actual deliverable is the SHAPES Interoperability Reference Testing Environment. This testing environment designed and developed to facilitate the validation process of the data correctness of the information exchanged among the SHAPES Digital Solutions.

This report serves two purposes: a) to provide the details and credentials to access the testing environment and b) to demonstrate the functionality of the testing environment.

For simplicity, in the rest of the document, the SHAPES Interoperability Reference Testing Environment will also be referred to as testing environment. In addition, the term “partners” is used to denote both the partners of the SHAPES consortium as well as those coming in from the open calls.

The current report is structured as follows:

- **Section 2:** Description of the SHAPES Interoperability Reference Testing Environment.
- **Section 3:** Demonstration of the functionality of the SHAPES Interoperability Reference Testing Environment. For the purpose of the demonstration, the FHIR specification is used
- **Section 4:** Concluding summary of the present report

1 Introduction

This report accompanies the D4.6 SHAPES Interoperability Reference Testing Environment. D4.6 is categorised as “OTHER” and the actual deliverable is the SHAPES Interoperability Reference Testing Environment. This testing environment designed and developed to facilitate the validation process of the data correctness of the information exchanged among the SHAPES Digital Solutions.

This report serves two purposes: a) to provide the details and credentials to access the testing environment and b) to demonstrate the functionality of the testing environment.

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1.1 Structure of the document

The remaining of the report is structured as follows:

- **Section 2:** Description of the SHAPES Interoperability Reference Testing Environment.
- **Section 3:** Demonstration of the functionality of the SHAPES Interoperability Reference Testing Environment. For the purpose of the demonstration, the FHIR specification is used.
- **Section 4:** Concluding summary of the present report

2 SHAPES Interoperability Reference Testing Environment

2.1 Rationale and development of the SHAPES Interoperability Reference Testing Environment

The SHAPES Interoperability Reference Testing Environment is an online platform, accessible to the partners, that facilitates the interoperability testing among the Digital Solutions (DS). In particular, it allows the partners to validate that the messages they aim to exchange between their DS and another DS conforms to the specified standard. This is achieved by the functionalities provided by the testing environment, namely:

- a) Allow the upload of JSON schemas which contain the format against which the messages shall be validated.
- b) Run the validator and observe if there are any errors in the message. All identified errors are presented to the user in order for the latter to update their message and re-run the validator until the message conforms fully to the schema provided.

The testing environment has been implemented using the following technologies:

- 1) Java Development Kit 1.11 has been used as the software development language and kit.
- 2) Vaadin Framework has been utilized to build the User Interface of the environment.
- 3) Java Spring Boot has been selected as the software framework to implement the services of the testing environment.
- 4) JSON Schema Validator is integrated to allow for custom schemas to be uploaded in the environment.

2.2 Access to the testing environment

The testing environment can be accessed via the following link:

<https://shapes-testing.gnomon.com.gr>

A test account has been created with the following credentials:

Username: **shapes**

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Password: **wZ9JamDR7gaZ**

2.3 Example of the Fast Healthcare Interoperability Resources (FHIR) validator

In order to demonstrate the capability of the testing environment, the FHIR Validation Library and in particular the Instance Validator has been integrated.

The Instance Validator is validation of the raw or parsed resource against the official FHIR validation rules (i.e. the official FHIR definitions, expressed as profile resources such as StructureDefinition and ValueSet). The Instance Validator can also be used to validate resources against individual Implementation Guides which derive from the core specification (e.g., the US Coreimplementation guide).

On top of the Instance Validator, custom rules have been implemented.

The next section further demonstrates the functionality of the testing environment that allows the users to upload their files (messages) and validate them against the selected validator (agreed specification).

3 Demonstration of the SHAPES Interoperability Reference Testing Environment

In order to demonstrate the functionality of the testing environment, an example of validating Fast Healthcare Interoperability Resources (FHIR) is provided.

Fast Healthcare Interoperability Resources (FHIR) is a platform specification that defines a set of data formats and elements (resources) as well as an application programming interface (API) to allow the seamless exchange of electronic health records. FHIR is created by Health Level Seven International (HL7), an organisation founded in 1987 and dedicated to the creation of framework and related standards for the exchange, integration, sharing and retrieval of electronic health information¹.

As mentioned in D4.1, in the context of the SHAPES ecosystem, FHIR is used as a healthcare interoperability standard to establish interoperability among SHAPES Digital Solutions and external solutions that will need to interact with the SHAPES ecosystem.

The following three communication scenarios are foreseen within the SHAPES ecosystem:

- 1) Exchange of non-IoT medical data between Digital Solutions (DS). For example, a DS #1 exchanges medical record information with DS #2.
- 2) Exchange of non-IoT medical data between a DS and the Big Data Platform. For example, the DS exchanges patient demographics information that is required by the big data platform to perform relevant data analysis.
- 3) Exchange of non IoT medical data between third party DS that are integrated within the SHAPES ecosystem.

From a technical point of view, FHIR messages are composed of a set of FHIR resources which represent the data that will need to be exchanged. Below, there is an example of FHIR resource which represent the “Patient”. The FHIR resources are available both in XML and JSON format.

```
<Patient xmlns="http://hl7.org/fhir">
  <!-- from Resource: id, meta, implicitRules, and language -->
  <!-- from DomainResource: text, contained, extension, and modifierExtension -->
```

¹ <http://www.hl7.org/index.cfm>

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```

<identifier><!-- 0..* Identifier An identifier for this patient --></identifier>
<active value="[boolean]" /><!-- 0..1 Whether this patient's record is in active use -->
<name><!-- 0..* HumanName A name associated with the patient --></name>
<telecom><!-- 0..* ContactPoint A contact detail for the individual --></telecom>
<gender value="[code]" /><!-- 0..1 male | female | other | unknown -->
<birthDate value="[date]" /><!-- 0..1 The date of birth for the individual -->
<deceased[x]><!-- 0..1 boolean|dateTime Indicates if the individual is deceased or not --></deceased[x]>
<address><!-- 0..* Address Addresses for the individual --></address>
<maritalStatus><!-- 0..1 CodeableConcept Marital (civil) status of a patient --></maritalStatus>
<multipleBirth[x]><!-- 0..1 boolean|integer Whether patient is part of a multiple birth --></multipleBirth[x]>
<photo><!-- 0..* Attachment Image of the patient --></photo>
<contact> <!-- 0..* A contact party (e.g. guardian, partner, friend) for the patient -->
  <relationship><!-- 0..* CodeableConcept The kind of relationship --></relationship>
  <name><!-- 0..1 HumanName A name associated with the contact person --></name>
  <telecom><!-- 0..* ContactPoint A contact detail for the person --></telecom>
  <address><!-- 0..1 Address Address for the contact person --></address>
  <gender value="[code]" /><!-- 0..1 male | female | other | unknown -->
  <organization><!-- ?? 0..1 Reference(Organization) Organization that is associated with the contact --></organiz
ation>
  <period><!-- 0..1 Period The period during which this contact person or organization is valid to be contacted rela
ting to this patient --></period>
</contact>
<animal> <!-- 0..1 This patient is known to be an animal (non-human) -->
  <species><!-- 1..1 CodeableConcept E.g. Dog, Cow --></species>
  <breed><!-- 0..1 CodeableConcept E.g. Poodle, Angus --></breed>
  <genderStatus><!-- 0..1 CodeableConcept E.g. Neutered, Intact --></genderStatus>
</animal>
<communication> <!-- 0..* A list of Languages which may be used to communicate with the patient about his or
her health -->
  <language><!-- 1..1 CodeableConcept The language which can be used to communicate with the patient about
his or her health --></language>
  <preferred value="[boolean]" /><!-- 0..1 Language preference indicator -->
</communication>
<generalPractitioner><!-- 0..* Reference(Organization|Practitioner) Patient's nominated primary care provider -->
</generalPractitioner>
<managingOrganization><!-- 0..1 Reference(Organization) Organization that is the custodian of the patient recor
d --></managingOrganization>
<link> <!-- 0..* Link to another patient resource that concerns the same actual person -->
  <other><!-- 1..1 Reference(Patient|RelatedPerson) The other patient or related person resource that the link ref
ers to --></other>
  <type value="[code]" /><!-- 1..1 replaced-by | replaces | refer | seealso - type of link -->

```

```

</link>
</Patient>

```

Using the SHAPES Interoperability Reference Testing Environment, the partners can test and confirm that their FHIR messages are correctly formed and complying to the FHIR specifications. In case they are malformed, the testing environment indicates the errors.

3.1 Associated roles and functionalities

The testing environment accommodates two types of users: a) admin users, b) the end users.

3.1.1 Admin users

Admin users can perform the following actions:

- User management for the testing environment. New users can be added via the UI screen shown in Figure 1.
- Configure endpoints and issue api-key for each user (partner) that needs to use the environment, as shown in Figure 2.

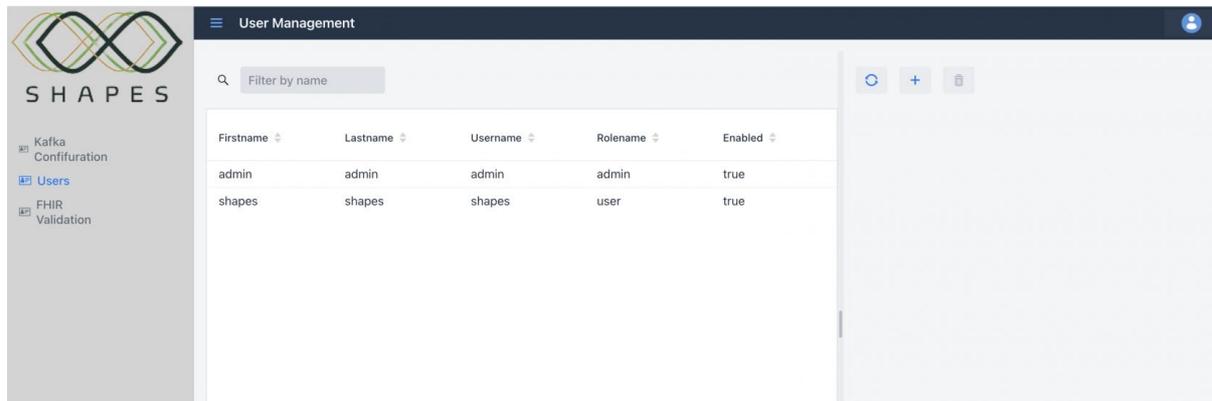


Figure 1 User management screen

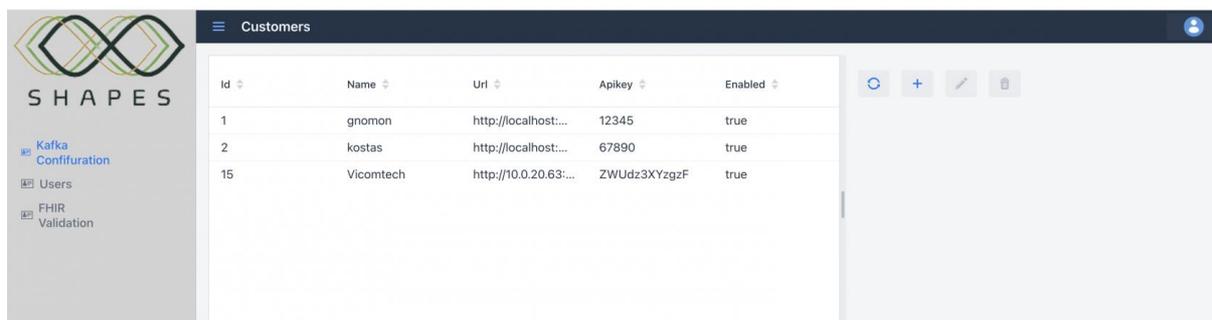


Figure 2 Configuration of new users

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3.1.2 End users

End users are the partners who need to use the testing environment to validate that the messages they intent to exchange with other partners (digital solutions) conform to the agreed specification.

The end users can perform the following functions:

- Login with the account created by the admin users
- Validate the correctness of their messages
- See examples of well-formed messages

3.1.2.1 Login to the testing environment

The end users can login to the testing environment using the credentials obtained by the admin users (Figure 3). Currently, new account requests can be directed to the Gnomon Informatics SA (GNO) partner.

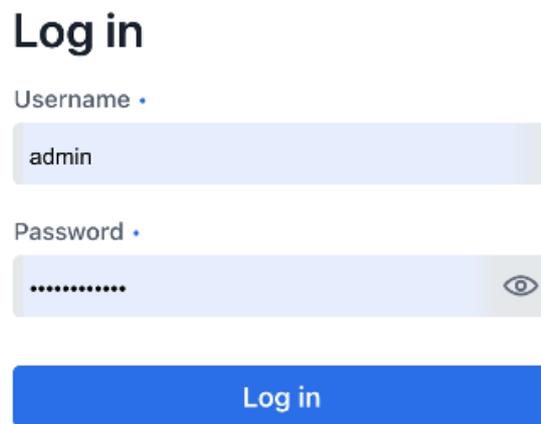


Figure 3 Login to the testing environment

3.1.2.2 Validate the correctness of the messages

The end users are able to upload their messages and perform a validation. The testing environment validates the correctness of the message and returns either “true” or “false”. In case there are errors (“false”), the testing environment prints a message with the identified errors. The end users can then update their messages and re-upload them for further validation until all errors are corrected.

Figure 4 shows an example of a FHIR message that needs to be validated. The message is a notification that is sent out from a DS #1 to DS #2. For example, it can be a notification of type “recommendation” for the user of the DS #2 that they need to consume more water on a daily basis.

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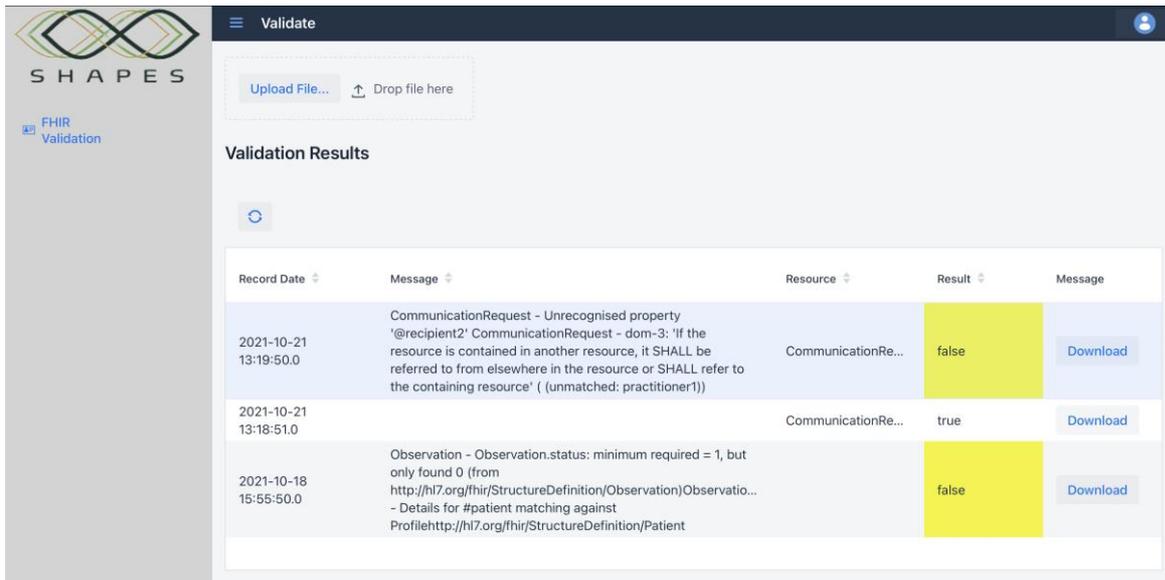


```
{
  "resourceType": "CommunicationRequest",
  "contained": [ {
    "resourceType": "Patient",
    "id": "patient1",
    "telecom": [ {
      "system": "email",
      "value": "test1@example.com"
    } ]
  },
  {
    "resourceType": "Practitioner",
    "id": "practitioner1",
    "telecom": [ {
      "system": "email",
      "value": "test2@example.com"
    } ]
  }
],
  "status": "active",
  "category": [ {
    "coding": [ {
      "system": "http://hl7.org/fhir/communication-category",
      "code": "notification",
      "display": "Notification"
    } ]
  }, {
    "coding": [ {
      "system": "https://gnomon4-fhir.gnomon.com.gr/EHP",
      "code": "recommendation",
      "display": "recommendation"
    } ]
  }
],
  "subject": {
    "reference": "#patient1"
  },
  "authoredOn": "2021-10-19T07:06:33+00:00",
  "recipient": [ {
    "reference": "#patient1"
  }, {
    "reference": "#practitioner1"
  } ],
  "note": [ {
    "text": "You need to increase the amount of daily water intake"
  } ]
}
```

Figure 4 Example of notification message

Figure 5 shows how the validation is performed via the testing environment. First the file, containing the message to be validated, is uploaded on the platform. Then, the testing environment analyses the message and responds with “true” or ‘false’. Figure 5 shows that the file (in Figure 4) uploaded on the “2021-10-21 13:18:51.0” has been a correct one (“true”). Then, for the purpose of the demonstration, an error was introduced in the message and the file has been uploaded again for validation. As observed, the testing environment responds with “false” and prints the error identified under the “Message” column.



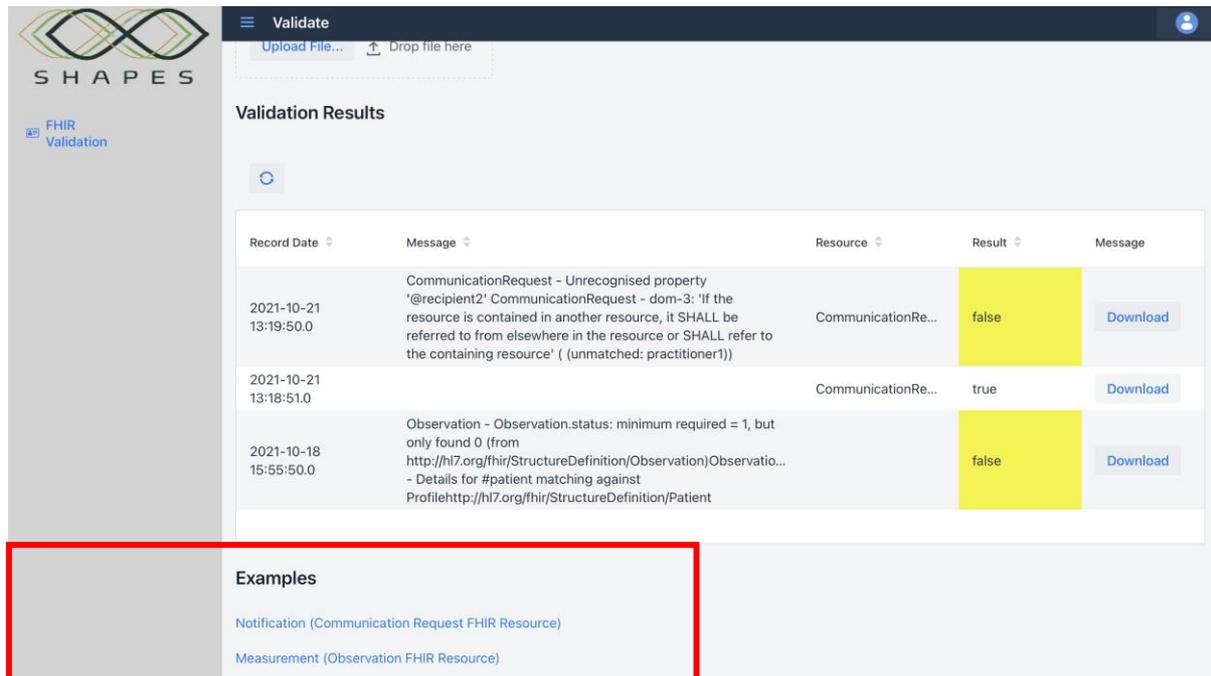


Record Date	Message	Resource	Result	Message
2021-10-21 13:19:50.0	CommunicationRequest - Unrecognised property '@recipient2' CommunicationRequest - dom-3: 'If the resource is contained in another resource, it SHALL be referred to from elsewhere in the resource or SHALL refer to the containing resource' ((unmatched: practitioner1))	CommunicationRe...	false	Download
2021-10-21 13:18:51.0		CommunicationRe...	true	Download
2021-10-18 15:55:50.0	Observation - Observation.status: minimum required = 1, but only found 0 (from http://hl7.org/fhir/StructureDefinition/Observation)Observatio... - Details for #patient matching against Profilehttp://hl7.org/fhir/StructureDefinition/Patient		false	Download

Figure 5 Validation of the messages

3.1.2.3 Examples of well-formed messages

In order to help partners in the process of creating their messages, examples of well-formed messages can be included in the testing environment (Figure 6).



Record Date	Message	Resource	Result	Message
2021-10-21 13:19:50.0	CommunicationRequest - Unrecognised property '@recipient2' CommunicationRequest - dom-3: 'If the resource is contained in another resource, it SHALL be referred to from elsewhere in the resource or SHALL refer to the containing resource' ((unmatched: practitioner1))	CommunicationRe...	false	Download
2021-10-21 13:18:51.0		CommunicationRe...	true	Download
2021-10-18 15:55:50.0	Observation - Observation.status: minimum required = 1, but only found 0 (from http://hl7.org/fhir/StructureDefinition/Observation)Observatio... - Details for #patient matching against Profilehttp://hl7.org/fhir/StructureDefinition/Patient		false	Download

Examples
Notification (Communication Request FHIR Resource)
Measurement (Observation FHIR Resource)

Figure 6 Examples of well-formed messages

4 Conclusion

This report introduced and accompanied the SHAPES Interoperability Reference Testing Environment. The testing environment aims to facilitate the interoperability among the Digital Solutions offered by the partners. It particularly provides the infrastructure for the partners to test the information exchanged via the Digital Solutions and ensure conformance to the agreed specification.

In order to demonstrate the functionality of the testing environment, the FHIR specification has been used. The FHIR validator has been integrated with the testing environment in order to enable validation of the FHIR messages.

As an example, a notification message has been created using the FHIR resources. Then the message has been uploaded on the testing environment to be validated against the FHIR specification. The testing environment analysed the message and responded with the results. In the case of errors, these were presented to the user for the latter to be able to update the message and re-perform the validation.

5 Ethical Requirements Check

Ethical issue (corresponding number of D8.4 subsection in parenthesis)	How we have taken this into account in this deliverable (if relevant)
Fundamental Rights (3.1)	n/a
Biomedical Ethics and Ethics of Care (3.2)	n/a
CRPD and supported decision-making (3.3)	n/a
Capabilities approach (3.4)	n/a
Sustainable Development and CSR (4.1)	n/a
Customer logic approach (4.2)	n/a
Artificial intelligence (4.3)	n/a
Digital transformation (4.4)	n/a
Privacy and data protection (5)	n/a
Cyber security and resilience (6)	n/a
Digital inclusion (7.1)	n/a
The moral division of labor (7.2)	n/a
Care givers and welfare technology (7.3)	n/a
Movement of caregivers across Europe (7.4)	n/a