LumiraDx

A system for detection of SARS-CoV-2 antigen and antibodies, PT (INR) and D-Dimer manufactured by LumiraDx UK Ltd

An evaluation of the detection of SARS-CoV-2 antigen

Report from the evaluation SKUP/2021/124

organised by SKUP at the request of LumiraDx AS

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Attachments with raw data are included only in the copy to LumiraDx AS.

1. Summary

Background
The LumiraDx system is an in vitro diagnostic point of care device for detection of Severe Acute Respiratory Syndrome Coronavirus 2 antigen (SARS-CoV-2 Ag) in nasal and nasopharyngeal swab specimens. The system is intended for professional use. LumiraDx is manufactured by LumiraDx UK Ltd. and the Ag test was launched into the Scandinavian market November 2020. This SKUP evaluation was carried out from October to December 2020 at the request of LumiraDx AS in Norway.

The aim of the evaluation
The aim of the evaluation was to assess the diagnostic performance and user-friendliness of LumiraDx SARS-CoV-2 Ag test when used under real life conditions by intended users in a dedicated Covid-19 testing centre.

Materials and methods
One nasal and two nasopharyngeal swab samples were taken at the same time from 450 subjects at Bergen Accident and Emergency Clinic. The subjects, 16 years or older, had been exposed to an individual who had previously tested positive for SARS-CoV-2. The nasal swab and one of the nasopharyngeal swabs were used for measurement with LumiraDx SARS-CoV-2 Ag Test, and the other nasopharyngeal swab was sent to the clinical microbiology laboratory at Haukeland University Hospital for measurement on an in-house RT-PCR comparison method. The diagnostic performance of the test was discussed related to present literature, mainly World Health Organization (WHO) recommendations. User-friendliness was assessed using a questionnaire with three ratings: satisfactory, intermediate and unsatisfactory, and with the quality goal of a total rating of "satisfactory".

Results
The prevalence of SARS-CoV-2 among the participants in this evaluation was 18,5 %. The overall diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test was 87 % for the nasal samples and 90 % for the nasopharyngeal samples. Of the 11 false negative nasal results and the eight false negative nasopharyngeal results, five and four participants, respectively, had ct values ≥33. The diagnostic specificity was 99,5 % for the nasal samples and 97,8 % for the nasopharyngeal samples. The positive predictive values of the test were 97 % for the nasal samples and 90 % for the nasopharyngeal samples. The negative predictive values of the test were 97,1 % for the nasal samples and 97,8 % for the nasopharyngeal samples. The user-friendliness was rated as satisfactory.

Conclusion
The WHO suggested minimum performance requirements of ≥80 % sensitivity and ≥97 % specificity compared to a reference assay were met by LumiraDx SARS-CoV-2 Ag test both for the nasal and nasopharyngeal samples when used under real-life conditions by the intended users. The quality goal for user-friendliness was fulfilled.

Comments from LumraDx AS
A letter with comments from LumiraDx AS is attached to the report.

This summary will also be published in Danish, Norwegian and Swedish at www.skup.org

2. Abbreviations and Acronyms

Ag	Antigen
Ag-RDT	Antigen-detecting Rapid Diagnostic Test
BLS	Biomedical Laboratory Scientist
C-NPU	Committee on Nomenclature, Properties and Units
CI	Confidence Interval
Ct value	Cycle threshold-value
Covid-19	Coronavirus Disease 2019
DEKS	Danish Institute of External Quality Assurance for Laboratories in Health Care
EHR	Electronic Health Record
EQA	External Quality Assessment
Equalis	External quality assessment in laboratory medicine in Sweden
NAATs	Nucleic Acid Amplification Tests
Noklus	Norwegian Organization for Quality Improvement of Laboratory Examinations
NPV	Negative Predictive Value
POC	Point of care
PPV	Positive Predictive Value
QCMD	Quality Control for Molecular Diagnostics
RFID	Radio-frequency identification
RNA	Ribonucleic acid
RT-PCR	Real Time Polymerase Chain reaction
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SKUP	Scandinavian evaluation of laboratory equipment for point of care testing
WHO	World Health Organization

3. Introduction

The purpose of Scandinavian evaluation of laboratory equipment for point of care testing (SKUP) is to improve the quality of near patient testing in Scandinavia by providing objective information about analytical quality and user-friendliness of laboratory equipment. This information is generated by organising SKUP evaluations in point of care (POC) settings.

3.1. The concept of SKUP evaluations

SKUP evaluations follow common guidelines and the results from various evaluations are comparable[1]. The evaluation set-up and details are described in an evaluation protocol and agreed upon in advance. The analytical results and user-friendliness are assessed according to pre-set quality goals. To fully demonstrate the quality of a product, the end-users should be involved in the evaluation. If possible, SKUP evaluations are carried out using three lot numbers of test strips from separate and time-spread productions. Some evaluation codes are followed by an asterisk (*), indicating an evaluation with a more specific objective. The asterisk is explained on the front page of these protocols and reports.

3.2. Background for the evaluation

In December 2019, Wuhan city in Hubei Province, China, became the center of an outbreak of a severe pneumonia, later identified as caused by a novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [1]. The virus causes coronavirus disease 2019 (Covid-19). Currently Covid-19 is mainly diagnosed by detection of ribonucleic acid (RNA) from SARS-CoV-2 using nucleic acid amplification tests (NAATs), such as real time polymerase chain reaction (RT-PCR) assays in a sample collected with a swab from the upper airways. RT-PCR is performed in clinical microbiology laboratories, requiring advanced analytical instruments and trained personnel. The ease-of-use and rapid turnaround time of antigen-detecting rapid diagnostic tests (Ag-RDTs) offer decentralized testing that potentially can expand access to testing and decrease delays in diagnosis [2].

The LumiraDx system is an in vitro diagnostic point of care (POC) multi-analyzer for detection of PT (INR), D-Dimer and SARS-Cov-2 antibodies (Ab) in capillary whole blood, plasma or serum and SARS-CoV-2 antigen (Ag) in nasal and nasopharyngeal swab specimens. The system is intended for professional use. LumiraDx is manufactured by LumiraDx UK Ltd. The SARS-CoV-2 Ag and Ab test was launched into the Scandinavian market November 2020. This SKUP evaluation focuses on the evaluation of the SARS-CoV-2 Ag test and was carried out from October to December 2020 at the request of LumiraDx AS in Norway.

3.3. The aim of the evaluation

The aim of the evaluation was to assess the diagnostic performance and user-friendliness of LumiraDx SARS-CoV-2 Ag Test when used under real life conditions by intended users in a dedicated Covid-19 testing centre.

[1]SKUP evaluations are under continuous development. In some cases, it may be difficult to compare earlier protocols, results and reports with more recent ones.

3.4. The model for the evaluation of LumiraDx SARS-CoV-2 Ag Test

The evaluation was carried out in a primary care emergency unit that served as a Covid-19 test centre, to evaluate the performance of LumiraDx SARS-CoV-2 Ag Test in the hands of the intended users, see flowchart in figure 1.

The evaluation included:

- Examination of the diagnostic performance (diagnostic sensitivity and specificity) of LumiraDx SARS-CoV-2 Ag Test using nasal swab specimens.
- Examination of the diagnostic performance (diagnostic sensitivity and specificity) of the LumiraDx SARS-CoV-2 Ag Test using nasopharyngeal swab specimens.
- Examination of the diagnostic performance of LumiraDx SARS-CoV-2 Ag Test related to different clinical cut-offs and different cycle threshold (ct) values from the RT-PCR method and
- Evaluation of the user-friendliness of the LumiraDx SARS-CoV-2 Ag Test and its manual.

In addition, the positive predictive value (PPV) and negative predictive value (NPV) were calculated.

All the measurements on the LumiraDx system were performed by the intended users who are professional health care providers working at the test centre. Subjects exposed to an individual who had previously tested positive for SARS-CoV-2 were included, e.g. targeted testing of household members or equivalent close contacts. Both symptomatic and asymptomatic participants were included. Household transmission of SARS-CoV-2 is reported to be high [3] and a prevalence of approximately 20-30 % was expected. Target number of participants were 100 positive results and 100 negative results, but maximum number included was 500. For comparison and assessment of the diagnostic sensitivity and specificity, a nasopharyngeal sample taken from the same patients during the same sampling session was measured on an RT-PCR comparison method.

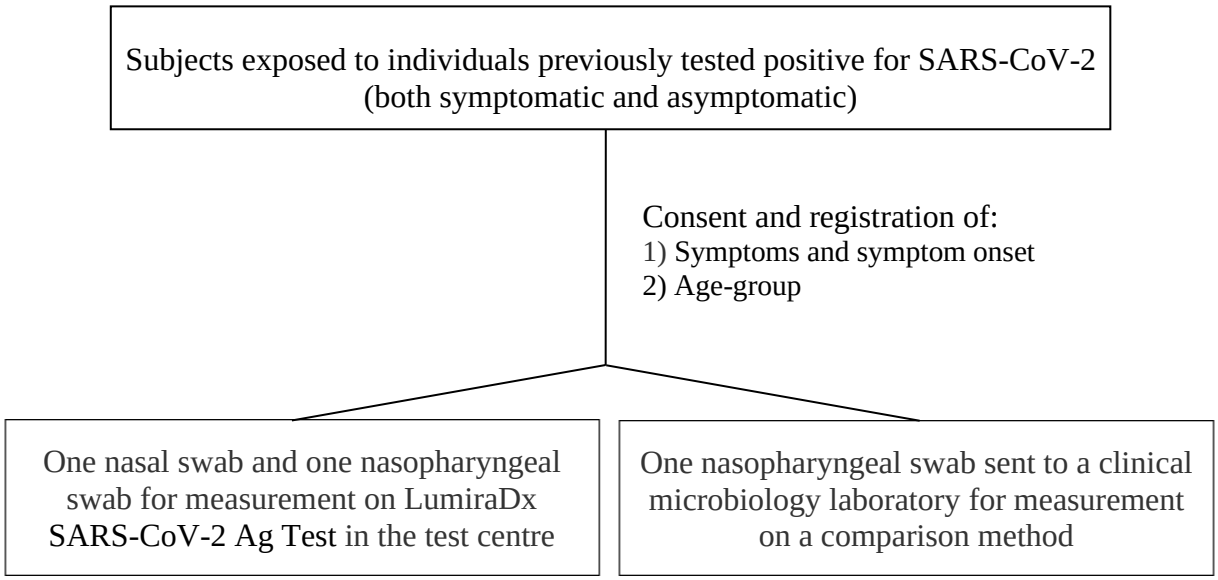

Figure 1. Flowchart illustrating the model of the evaluation. Enrolment of participants continued until at least 100 positive and at least 100 negative SARS-CoV-2 PCR results were achieved in the clinical microbiology laboratory, but maximum number included was 500.

4. Quality goals

4.1. Analytical quality

Present recommendations for diagnostic SARS-CoV-2 tests

The World Health Organization (WHO) [2] suggests that SARS-CoV-2 Ag-RDTs that meet the minimum performance requirements of ≥80 % sensitivity and ≥97 % specificity compared to a NAAT reference assay can be used to diagnose SARS-CoV-2 infection where NAAT is unavailable or where prolonged turnaround times preclude clinical utility. In settings with low prevalence of active SARS-CoV-2 infections specificity should ideally be ≥99 % to avoid many false-positive results.

4.2. User-friendliness

The evaluation of user-friendliness was carried out by asking the employees in the test centre to fill in a questionnaire, see section 5.5.

Technical errors

SKUP recommends that the fraction of tests wasted due to technical errors should not exceed 2 %.

4.3. Principles for the assessments

To qualify for an overall good assessment in a SKUP evaluation, the measuring system must show satisfactory analytical quality as well as satisfactory user-friendliness.

4.3.1. Assessment of the analytical quality

The analytical results are described and discussed related to literature. Statistical expressions and calculations used by SKUP are shown in attachment 5.

Diagnostic sensitivity

The diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test was calculated by comparing the test results from LumiraDx SARS-CoV-2 Ag Test with the RT-PCR results from participants with positive RT-PCR results. The calculated result is given with a 90 % confidence interval (CI) (for information only).

Diagnostic specificity

The diagnostic specificity of LumiraDx SARS-CoV-2 Ag Test was calculated by comparing the test results from LumiraDx SARS-CoV-2 Ag Test with the RT-PCR results from participants with negative RT-PCR results. The calculated result is given with a 90 % CI (for information only).

Positive and negative predictive values

PPV and NPV were calculated given the prevalence in the tested population and the achieved diagnostic accuracy of the test.

Assessment of three lots
Three lots of test kits were used for the purpose of having an evaluation less sensitive to the risk of a poor batch. Separate lot calculations were not performed.

Examination of different clinical cut-offs
Sensitivity and specificity were calculated for results stratified on symptoms/no symptoms and days since symptom onset.

Examination of different ct values from the RT-PCR method
The ct value is defined as the number of cycles of amplification required with RT-PCR for the fluorescent signal to reach a threshold above the background signal. and is inversely proportional to the amount of target nucleic acid in the sample (i.e., the lower the ct value the greater the amount of target nucleic acid in the sample). Sensitivity was calculated for results stratified on ct values; ct <33, ct<30 and ct<25.

4.3.2. Assessment of user-friendliness

User-friendliness is assessed according to answers and comments given in the questionnaire (see section 6.5). For each question, the evaluator can choose between three given ratings; satisfactory, intermediate and unsatisfactory. To achieve the overall rating "satisfactory", the tested equipment must reach a total rating of "satisfactory" in all four subareas of characteristics described in section 6.5.

Technical errors
The evaluators registered error codes, technical errors and failed measurements during the evaluation. The proportion of tests wasted due to technical errors was calculated and taken into account in connection with the assessment of the user-friendliness. User errors related to the handling of the samples were excluded from the calculations.

4.4. SKUP's quality goals in this evaluation

For this evaluation, there were no pre-set quality goals for the diagnostic performance of the test. The results are nevertheless discussed related to present literature, specifically WHO recommendations.

For assessment of the user-friendliness:

User-friendliness, overall rating..... Satisfactory

5. Materials and methods

5.1. Definition of the measurand

The measurement systems intend to detect SARS-CoV-2 antigen in secrete from the nostrils and nasopharynx. For the comparison method the RNA from SARS-CoV-2 is identified by RT-PCR. The results are expressed on an ordinal scale (positive or negative) for both methods. The Committee on Nomenclature, Properties and Units (C-NPU) systematically describes clinical laboratory measurands in a database [4]. The NPU codes related to the evaluated method are NPU59312 (vestibulum nasi) and NPU59310 (nasopharynx). The NPU code related to the comparison method is NPU59105. In this protocol the term SARS-CoV-2 will be used for this measurand.

5.2. The evaluated measurement system LumiraDx SARS-CoV-2 Ag Test

The information in this section derives from the company's information material.

LumiraDx SARS-CoV-2 Ag Test (figure 2) is a point of care analyser intended for professional use for detection of SARS-CoV-2.

The LumiraDx SARS-CoV-2 Ag system includes:

- LumiraDx instrument
- LumiraDx SARS-CoV-2 Ag Test individually packed test strips
- Radio-frequency identification (RFID) tag inside the test strips carton
- Extraction buffer vials
- Dropper lids

Figure 2 LumiraDx SARS-CoV-2 Ag Test

The LumiraDx SARS-CoV-2 Ag Test is a rapid microfluidic immunofluorescence assay for use with the LumiraDx Platform intended for the detection of the nucleocapsid protein antigen to SARS-CoV-2 directly from nasal or nasopharyngeal swab samples collected from individuals suspected of Covid-19 within the first twelve days of symptom onset or from asymptomatic individuals.

The test procedure involves collecting a nasal or nasopharyngeal specimen, using a recommended swab, which is eluted into a vial containing extraction buffer. The extraction buffer with the specimen is stable for five hours. A single drop of the specimen in extraction buffer is added to the test strip using the vial dropper cap provided. The LumiraDx instrument is programmed to perform the test protocol using the dried reagents contained within the strips. The test result is determined from the intensity of fluorescence detected by the instrument within the measurement zone of the test strip. The fluorescence is proportional to the concentration of the analyte in the specimen. The results are displayed on the instrument touchscreen within 12 minutes from the addition of the sample.

Before measurements of a new lot of test strips the kit box should be scanned for RFID, containing lot specific information about the calibration. Single or multiple instruments can be connected to the LumiraDx Connect Manager for extended functionality and configuration. LumiraDx EHR Connect can enable the transfer of patient test results to the electronic health record (EHR).

For technical details about the LumiraDx SARS-CoV-2 Ag Test, see table 1. For more information about the Lumira SARS-CoV-2 Ag Test system, and name of the manufacturer and the suppliers in the Scandinavian countries, see attachments 2 and 3. For product specifications in this evaluation, see attachment 4.

Table 1. Technical details from the manufacturer

Technical details for LumiraDx SARS-CoV-2 Ag Test	
Sample material	Nasal or nasopharyngeal specimen
Stability of extraction buffer including specimen	5 hours
Measuring time	12 minutes
Storage capacity	1000 test results including date, time and comments

5.3. The selected comparison method

A selected comparison method is a fully specified method which, in the absence of a Reference method, serves as a common basis for the comparison of the evaluated method.

5.3.1. The selected comparison method in this evaluation

The selected comparison method in this evaluation was the routine RT-PCR method for SARS-CoV-2 in the Department of Microbiology, Haukeland University Hospital in Bergen, Norway, hereafter called “the comparison method”. The laboratory is accredited according to NS-EN ISO/IEC 15189 (2012) (Norsk Standard_Europeisk Norm International Organization for Standardization). The division performing the PCR measurements has approximately 30 employees.

Instruments:	Lightcycler 480 (Roche) or Quantstudio 5 (Applied biosystems)
Reagent:	In-house RT-PCR. Mastermix: QuantiNova® Pathogen + IC Kit (Qiagen)
Principle:	RT-PCR detection of the E gene of the Sarbeco Betacorona virus, including SARS-CoV-2 [5]

Internal analytical quality control

Kit-independent positive (positive patient samples) and negative (transport medium) controls are included in the extraction step. In addition, an internal control (bacteriophage with RNA) is added to each sample.

External analytical quality control

The laboratory participates in two different external quality assessment (EQA) schemes:

- Quality Control for Molecular Diagnostics (QCMD, United Kingdom) for SARS-CoV-2 with five samples in two challenges per year.
- INSTAND (Germany) Virus Genome Detection scheme (Coronaviruses including SARS-CoV-2) with six samples in two challenges per year.

The laboratory also participates in an interlaboratory comparison of microbiological samples organised by the Norwegian Institute of Public Health.

5.3.2. Verification of the analytical quality of the comparison method

Trueness

The trueness of the RT-PCR method for detection of SARS-CoV-2 was verified with EQA results for a period circumventing the evaluation period.

5.4. The evaluation

5.4.1. Planning of the evaluation

Inquiry about an evaluation

LumiraDx AS via Helena Olkkonen, Country Manager in Norway, applied to SKUP in August 2020 for an evaluation of LumiraDx SARS-CoV-2 Ag test.

Protocol, arrangements and contract

In October 2020, the protocol for the evaluation was approved, and LumiraDx AS and SKUP signed a contract for the evaluation. Bergen Accident and Emergency Clinic agreed to represent the intended users in this evaluation and the department of Microbiology, Haukeland University Hospital agreed to perform the comparison method.

Training

LumiraDx AS was responsible for the necessary training of the intended users in the test centre. The training reflected the training usually given to the end-users. LumiraDx AS was not allowed to contact or supervise the evaluators during the evaluation period.

5.4.2. Evaluation sites and persons involved

In the test centre three nurses, one nurse student and one medical student participated in the evaluation. They were all trained in collecting samples from upper airways and use both nasopharyngeal and oropharyngeal swab specimens in the routine work.

5.4.3. The evaluation procedure

Internal analytical quality controls for LumiraDx SARS-CoV-2 Ag Test, one positive and one negative, were performed each evaluation day, alternating between the positive and the negative control.

Recruitment of participants and ethical considerations

Subjects, 16 years or older, exposed to an individual who had previously tested positive for SARS-CoV-2 were asked if they were willing to participate in the evaluation of LumiraDx SARS-CoV-2 Ag Test. Participation was voluntary and verbal informed consent was considered sufficient. Approval from a regional ethical committee was not necessary because the evaluation

was considered a quality assurance project. The project was approved by the Data protection officer at Haraldsplass Deaconess Hospital.

Handling of the samples and measurements
Nasal swab (FLOQswabs CLASSIQ Copan) specimens and nasopharyngeal swab (Dryswab CNWE) specimens were used for the measurements on the LumiraDx SARS-CoV-2 Ag Test. A second nasopharyngeal swab specimen for the comparison method was taken during the same sampling session.

The sampling from each patient was carried out in the following order:
1. Nasopharyngeal swab from one nostril for the comparison method
2. One nasal swab with samples from both nostrils for the LumiraDx SARS-CoV-2 Ag Test
3. A second nasopharyngeal swab from the other nostril for the LumiraDx SARS-CoV-2 Ag Test

The swabs were collected according to the instructions in the user manual of LumiraDx SARS-CoV-2 Ag Test and immediately placed into the test vial containing extraction buffer. The extracted samples were analysed within two hours of collection, and in accordance with the instructions from the manufacturer. In case of error codes, the test was repeated if possible until a result was obtained. Three lot numbers of test strips were used in the evaluation.

The swabs for the comparison method were placed immediately into sterile tubes containing 2-3 mL of viral transport media. The tubes were kept at room temperature until transported to the clinical laboratory. All samples were treated according to the internal procedures of the laboratory regarding potential interfering substances. For samples with ct values > 35, five repeated measurements were performed.

6. Results and discussion

Statistical expressions and calculations used by SKUP are shown in attachment 5.

6.1. Number of samples and study population characteristics

The practical work was performed during nine weeks of autumn 2020, during which Bergen city experienced a major outbreak of Covid-19. In total, 450 participants provided samples for the evaluation, and 448 were successfully matched to their corresponding RT-PCR result. The vast majority were exposed to individuals who had previously tested positive for SARS-CoV-2, and 20 % were known household members. 44 % of the participants were in the age-group 20-29 years. 56 % (n=251) were symptomatic of which 87 % (n=219) had a symptom duration of ≤5 days. Of those with symptoms, 76 % (n=190) reported two or more symptoms, of which sore throat and headache were most commonly reported. 18,5 % (n=83) of participants were PCR positive. This is a higher prevalence of SARS-CoV-2 infection than in the general population. However, investigation among exposed subjects is highly relevant for contact tracing in institutions, semi-closed communities and among household members or equivalent close contacts. For more information about the study population, se table 2.

Table 2. Population characteristics of persons successfully included in the evaluation

	Total sucessfully included n (% of all)	**PCR positive results n (% of group)**	**PCR negative results n (% of group)**
Total	448 (100)	83 (18,5)	365 (81,5)
Age			
≤ 19	36 (8,0)	12 (33,3)	24 (66,7)
20-29	197 (44,0)	32 (16,2)	165 (83,8)
≥30	215 (48,0)	39 (18,1)	176 (81,9)
Symptomatic			
No	197 (44,0)	11 (5,6)	186 (94,4)
Yes	251 (56,0)	72 (28,7)	179 (71,3)
Symptom duration	**n (% of symptomatic)**		
≤ 5 days	219 (87,4)	56 (25,6)	163 (74,4)
> 5 days	9 (3,6)	5 (55,6)	4 (44,4)
Unknown	23 (9,2)	11 (47,8)	12 (52,2)

An account for the number of samples not included in the calculations, is given below.

Missing results

- Internal analytical quality control results for one evaluation day were missing. The results from the patient samples (SKUP ID 393-403) were still included in the calculations.
- ID 1, 128 and 133; these IDs were not used
- ID 48; registration form missing
- ID 170; no result for the nasopharyngeal sample because the specimen was sticky, and this resulted in error messages
- ID 182; no result from the RT-PCR method as the sample never arrived at the clinical laboratory

- ID 284 and 307; no result for the nasopharyngeal samples because the patients changed their minds regarding the additional nasopharyngeal samples
- ID 412, 413 and 441; not representative nasopharyngeal specimens for LumiraDx SARS-CoV-2 Ag Test

Omitted result

- ID 82; positive LumiraDx results for both the nasal and nasopharyngeal samples, but negative RT-PCR result for the parallel nasopharyngeal sample. Due to positive RT-PCR result three days later for this patient the negative PCR-result in the study is probably a false negative PCR-result caused by e.g., sampling error, and the results from this patient are not included in the calculations of diagnostic sensitivity and specificity.

Recorded error codes, technical errors and failed measurements

The operators registered the following error codes from the LumiraDx instrument during the evaluation:

- 1 x 003-3506; no explanation in the user-manual. Interpreted as technical error.
- 9 x 006-3510; error explained in the user-manual as "Instrument must be level and stationary to perform test. Place instrument on level, stable surface and start new test." Interpreted as technical errors.
- 1 x 016-3604, error explained in the user-manual as "Time exceeded to perform action. Test has timed out. Dispose of test strip and start again". Interpreted as user error.
- 2 x 016-3600; no explanation in the user-manual. Interpreted as user error and sticky sample by the operator.
- 13 x 038-3605; error explained in the user-manual as "Insufficient sample volume or instrument has experienced a problem and cannot complete test. Dispose of test strip and start new test. If problem persist, contact customer service." Ten incidences interpreted as technical errors and three as user errors.
- 1 x 108-1813; no explanation in the user-manual. Interpreted as technical error.
- 2 x 108-2224; no explanation in the user-manual. Interpreted as technical error.
- 1 x 108-3502; no explanation in the user-manual. Interpreted as technical error.
- 2 x 115-1303; no explanation in the user-manual. Interpreted as technical error. Replacement instruments were necessary.
- 1 x 115-1307; no explanation in the user-manual. Interpreted as technical error. Replacement instrument was necessary.

On two occasions, the instrument switched off in the middle of heating a test card and sample measurement.

The fraction of tests wasted due to technical errors was estimated to (29/892) x 100 = 3,3 %. Thus, the SKUP recommendation of a fraction of ≤2 % tests wasted caused by technical errors was not achieved.

6.2. Analytical quality of the selected comparison method

6.2.1. Internal analytical quality control

All results from the internal analytical quality controls were in accordance with the assigned values (data not shown).

6.2.2. The trueness of the comparison method

The trueness of the RT-PCR method for detection of SARS-CoV-2 was verified with EQA results for the period circumventing the evaluation period.

Table 3. EQA controls measured on the comparison method.

Time of measurements	EQA scheme	Assigned value, SARS-CoV-2	Results from the RT-PCR method (ct value)
Week 44	QCMD	Coronavirus OC43/negative	negative
		SARS CoV-2 3,27 dPCR Log10 Copies/ml	positive (33,6)
		SARS CoV-2 2,48 dPCR Log10 Copies/ml	positive (37,5)
		SARS CoV-2 2,48 dPCR Log10 Copies/ml	positive (37,0)
		negative	negative
Week 47 and 48	INSTAND	positive	positive (28,2)
		negative	negative
		positive	positive (26,8)
		negative	negative
		positive	positive (29,0)
		positive	positive (29,1)

Discussion

The trueness of the comparison method during the evaluation period was confirmed by the results from the QCMD and INSTAND EQA schemes for SARS-CoV-2.

6.3. Analytical quality of LumiraDx SARS-CoV-2 Ag Test

The results below reflect the analytical quality of LumiraDx SARS-CoV-2 Ag Test under real-life conditions in the hands of intended users at a dedicated testing centre.

6.3.1. Internal analytical quality control

All results from the internal analytical quality control (one positive and one negative LumiraDx SARS-CoV-2 Ag Quality Control), were in accordance with the assigned values for the quality control material (data not shown). Raw data is attached for the requesting company only, see attachment 7.

6.3.2. The diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test

The diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test was calculated by comparing the test results from LumiraDx SARS-CoV-2 Ag Test with the RT-PCR results in participants with

positive RT-PCR results, see tables 4 and 5. The calculations were done as described in Attachment 5 using the RT-PCR results as true values. The raw data is presented to the requesting company only, see attachment 7.

Table 4. Diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test measured in nasal specimen. Results achieved by intended users. Overall results and when using different clinical cut-offs.

	Total PCR positive results (n)	Number of true positive results (n)	Number of false negative results (n)	Diagnostic sensitivity % (90 % CI)
Total	83	72	11	87 (79-92)
Symptomatic				
No	11	8	3	73 (48-89)
Yes	72	64	8	89 (81-94)
≤ 5 days*	56	52	4	93 (85-97)
> 5 days*	5	4	1	**

An account for the number of samples is given in section 6.1.
*Days since symptom onset was unknown for 11 of the participants with a positive RT-PCR result.
**n <8; not reported due to high degree of uncertainty in the estimated sensitivity.

Table 5. Diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test measured in nasopharyngeal specimen. Results achieved by intended users. Overall results and when using different clinical cut-offs.

	Total PCR positive results (n)	Number of true positive results (n)	Number of false negative results (n)	Diagnostic sensitivity % (90 % CI)
Total	82	74	8	90 (83-95)
Symptomatic				
No	10	8	2	80 (49-96)
Yes	72	66	6	92 (84-96)
≤ 5 days*	56	52	4	93 (85-97)
> 5 days*	5	4	1	**

An account for the number of samples is given in section 6.1.
*Days since symptom onset was unknown for 11 of the participants with a positive RT-PCR result.
**n <8; not reported due to high degree of uncertainty in the estimated sensitivity.

6.3.3. Examination ct values from the RT-PCR method

The diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test was stratified on relevant ct values, see tables 6 and 7.

Table 6. Diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test measured in nasal specimen. Results achieved by intended users. Overall results and when stratified on ct values.

Ct values	Median ct value (min – max)	Total PCR positive results (n)	Number of true positive results (n)	Number of false negative results (n)	Diagnostic sensitivity % (90 % CI)
<40	22,7 (14,6 – 38,0)	83	72[1]	11[2]	87 (79-92)
<33	22,3 (14,6 – 31,7)	77	71	6	92 (85-96)
<30	22,2 (14,6 – 29,3)	73	69	4	95 (86-98)
<25	21,5 (14,6 – 24,9)	59	59	0	100 (97-100)

An account for the number of samples is given in section 6.1.
[1]Median ct value for the true positive results = 22,1, min: 14,6 max: 38,0
[2]Median ct value for the false negative results = 30,8, min: 25,3 max: 37,8. Unpaired t test (Excel) p-value<0,001 when comparing the means for the true positive and false negative results.

Table 7. Diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test measured in nasopharyngeal specimen. Results achieved by intended users. when stratified on ct values.

Ct values	Median ct value (min-max)	Total PCR positive results (n)	Number of true positive results (n)	Number of false negative results (n)	Diagnostic sensitivity % (90 % CI)
<40	22,6 (14,6 – 38,0)	82	74[1]	8[2]	90 (83-95)
<33	22,3 (14,6 – 31,7)	76	72	4	95 (89-98)
<30	22,0 (14,6 – 29,3)	72	69	3	96 (88-99)
<25	21,5 (14,6 – 24,9)	58	57	1	98 (92-100)

An account for the number of samples is given in section 6.1.
[1]Median ct value for the true positive results = 22,3, min: 14,6 max: 37,8
[2]Median ct value for the false negative results = 32,6, min: 19,5 max: 38,0. Unpaired t test (Excel) p-value<0,001 when comparing the means for the true positive and false negative results.

6.3.4. The diagnostic specificity of LumiraDx SARS-CoV-2 Ag Test

The diagnostic specificity of LumiraDx SARS-CoV-2 Ag Test was calculated by comparing the test results from the intended users with the RT-PCR results in participants with negative RT-PCR results, see tables 8 and 9. The calculations were done as described in Attachment 5 using the RT-PCR results as true values. The raw data is presented to the requesting company only, see attachment 7.

Table 8. Diagnostic specificity of LumiraDx SARS-CoV-2 Ag Test measured in nasal specimen. Results achieved by intended users. Overall results and when using different clinical cut-offs.

	Total PCR negative results (n)	Number of true negative results (n)	Number of false positive results (n)	Diagnostic specificity % (90 % CI)
Total	364	362	2	99,5 (98,3-99,9)
Symptomatic				
No	186	185	1	99,5 (97,4-100)
Yes	178	177	1	99,4 (97,3-100)
≤ 5 days*	162	162	0	100 (98,8-100)
> 5 days*	4	4	0	**

An account for the number of samples is given in section 6.1.
*Days since symptom onset unknown for 12 of the participants with a negative RT-PCR result.
**n <8; not reported due to high degree of uncertainty in the estimated sensitivity.

Table 9. Diagnostic specificity of LumiraDx SARS-CoV-2 Ag Test measured in nasopharyngeal specimen. Results achieved by intended users. Overall results and when using different clinical cut-offs.

	Total PCR negative results (n)	Number of true negative results (n)	Number of false positive results (n)	Diagnostic specificity % (90 % CI)
Total	359	351	8	97,8 (96,0-98,8)
Symptomatic				
No	182	179	3	98,4 (95,8-99,5)
Yes	177	172	5	97,2 (94,2-98,7)
≤ 5 days*	161	157	4	97,5 (94,4-99,0)
> 5 days*	4	4	0	**

An account for the number of samples is given in section 6.1.
*Days since symptom onset unknown for 12 of the participants with a negative RT-PCR result.
**n <8; not reported due to high degree of uncertainty in the estimated sensitivity.

Discussion

The overall diagnostic sensitivity of LumiraDx SARS-CoV-2 Ag Test was 87 % for the nasal samples and 90 % for the nasopharyngeal samples, when compared to the results from the comparison method. PPVs were 97 % and 90 % for the nasal samples and the nasopharyngeal samples, respectively.

56 % of the participants in the evaluation reported to have Covid-19 symptoms. The majority of the symptomatic participants (87 %) stated that the symptoms had lasted for less than five days. For these, the sensitivity was 93 % for both specimens. Participants tested more than 5-7 days since onset of symptoms are more likely to have lower viral loads, and the likelihood of false negative results with Ag-RDTs is higher [2]. In this evaluation the number of participants with known symptom duration for more than five days were small and due to high degree of uncertainty the estimated sensitivity was not calculated.

For participants without symptoms (44 %) the sensitivity was 73 % and 80 % for the nasal and nasopharyngeal samples, respectively, indicating that the test might have a lower sensitivity than in symptomatic patients although the 90 % CIs are overlapping. The number of asymptomatic

participants with PCR positive results are low, and the results must therefore be interpreted with caution.

The ct values from the comparison method are inversely proportional to the amount of target nucleic acid in the samples measured. The ct value can therefore give some indication of the viral load in the participant and it can be used to investigate the false negative results. The median ct values for the false negative LumiraDx SARS-CoV-2 Ag Test results were considerable higher than for the true positive results, se tables 6 and 7. Of the 11 false negative nasal results and the eight false negative nasopharyngeal results, five and four participants, respectively, had ct values ≥33 (interval from 33,5 to 38,0). Thus, low viral load may have contributed to a considerable proportion of the false negative results.

When only the participants with ct values below 30 were considered, the sensitivity increased to 95 % for the nasal samples and 96 % for the nasopharyngeal samples. Nine of the participants in the evaluation had ct values ≥30, which suggests that the participants either were in a pre-symptomatic or in a late phase of the infection, and probably non-infectious [6]. From an infection tracing perspective, however, they are still important.

The results stratified by ct values should be interpreted with caution. Due to differences in PCR technology across laboratories, ct values may differ despite equal RNA concentrations in a sample. There is no universal ct value indicating contagiousness. In addition, the viral load in a sample may be affected by preanalytical conditions, e.g. poor sampling can result in different viral loads in samples measured by the LumiraDx SARS-CoV-2 Ag Test and the comparison method even if collected from the same patient at the same time.

The overall diagnostic specificity was 99,5 % for the nasal samples and 97,8 % for the nasopharyngeal samples. NPVs were 97,1 % and 97,8 % for the nasal samples and the nasopharyngeal samples, respectively. Different clinical cut-offs did not seem to influence the estimated diagnostic specificity of the Ag test. The main concern of using an Ag test instead of a PCR method is the risk of false negative results, but if the disease prevalence is low (<1 %) the proportion of false positive results still becomes noticeable [7]. WHO therefore recommends a higher specificity (≥99 %) for the Ag-RDT tests if used in a low prevalence setting. This evaluation was performed in a population with higher prevalence of SARS-CoV-2 infection than in the general population.

Conclusion

LumiraDx SARS-CoV-2 Ag Test fulfills the WHO minimum performance requirement for diagnostic sensitivity (≥80 %) and specificity (≥97 %) when used under real life-conditions with a prevalence of 18,5 % by the intended users.

6.4. Evaluation of user-friendliness

6.4.1. Questionnaire to the evaluators

The most important responses regarding user-friendliness come from the intended users themselves. The end-users often emphasise other aspects than those pointed out by more extensively trained laboratory personnel.

At the end of the evaluation period, the intended users filled in a questionnaire about the user-friendliness of the measurement system. SKUP has prepared detailed instructions for this.

The questionnaire is divided into four subareas:

Table A) Rating of operation facilities. Is the system easy to handle?
Table B) Rating of the information in the manual / insert / quick guide
Table C) Rating of time factors for the preparation and the measurement
Table D) Rating of performing internal and external analytical quality control

The intended users filled in table A and B. SKUP filled in table C and D and in addition, topics marked with grey colour in table A and B.

In the tables, the first column shows what property is evaluated. The second column in table A and B shows the rating by the users at the evaluation sites (one letter per evaluator). The rest of the columns show the rating options. The overall ratings from all the evaluating sites are marked in coloured and bold text. The total rating is an overall assessment by SKUP of the described property, and not necessarily the arithmetic mean of the rating in the rows. Consequently, a single poor rating can justify an overall poor rating, if this property seriously influences on the user-friendliness of the system.

Unsatisfactory and intermediate ratings are marked with a number and explained below the tables. The intermediate category covers neutral ratings assessed as neither good nor bad.

An assessment of the user-friendliness is subjective, and the topics in the questionnaire may be emphasised differently by different users. The assessment can therefore vary between different persons and between the countries. This will be discussed and taken into account in the overall assessment of the user-friendliness.

Comment
In this evaluation, the user-friendliness was assessed individually by two nurses, one nurse student and one medical student.

Table A. Rating of operation facilities

Topic	Rating	Rating	Rating	Rating	Option
To prepare the test / instrument	S, S, S, I[1]	Satisfactory	Intermediate	Unsatisfactory	No opinion
To prepare the sample	S, S, S, S	Satisfactory	Intermediate	Unsatisfactory	No opinion
Application of specimen	S, S, S, I[2]	Satisfactory	Intermediate	Unsatisfactory	No opinion
Specimen volume*	S, S, S, I[3]	Satisfactory	Intermediate	Unsatisfactory	No opinion
Number of procedure step	S, S, S, S	Satisfactory	Intermediate	Unsatisfactory	No opinion
Instrument / test design	S, S, I[4], S	Satisfactory	Intermediate	Unsatisfactory	No opinion
Reading of the test result	S, S, S, S	Easy	Intermediate	Difficult	No opinion
Sources of errors	S, I[5], I[6], I[1]	Satisfactory	Intermediate	Unsatisfactory	No opinion
Cleaning / Maintenance	S, S, S, S	Satisfactory	Intermediate	Unsatisfactory	No opinion
Hygiene, when using the test	S, S, S, S	Satisfactory	Intermediate	Unsatisfactory	No opinion
Size and weight of instrument	S, S, S, S	Satisfactory	Intermediate	Unsatisfactory	No opinion
Storage conditions for tests, unopened package	S	+15 to +30°C	+2 to +8°C	–20°C	
Storage conditions for tests, opened package	S	+15 to +30°C or disposable	+2 to +8°C	–20°C	
Environmental aspects: waste handling	S	No precautions	Sorted waste	Special precautions	
Intended users	S	Health care personnel or patients	Laboratory experience	Biomedical laboratory scientists	
Total rating by SKUP		Satisfactory			

*E.g. assessed on whether the volume of extraction buffer was sufficient for repeated measurements.
[1]Multiple error messages during start-up.
[2]Application of the analytical quality control material can be challenging due to air bubbles in the pipette.
[3]Sometimes difficult to squeeze out the sample, and sometimes difficult to only squeeze out one drop.
[4]Easy to handle but makes a lot of noise.
[5]Messages on unstable surface even when the instrument was at rest. Erroneous messages about insufficient sample volume caused significant loss of test strips.
[6]Multiple error messages related to the barcode scanner and messages of unstable surface when the instrument was placed on a horizontal surface and not moved.

Additional positive comments:
Easy to use with clear stepwise instructions during the whole analytical process.
Informative messages throughout the analytical process are a good tool for preventing mistakes during measurements. The instrument interrupts the measurement if the operator performs the procedure incorrectly. An overall easy and good instrument. Easy to understand and good screen size.

Additional negative comments:
The ID number of the samples disappears during pre-heating of the test strip. This can be a source of error if analysing on multiple instruments simultaneously.

Table B. Rating of the information in the manual and quick guide

Topic	Rating	Rating	Rating	Rating	Option
Table of contents/Index	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
Preparations/Pre-analytic procedure	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
Specimen collection	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
Measurement procedure	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
Reading of result	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
Description of the sources of error	**S, I[1], I[1], I[1]**	**Satisfactory**	**Intermediate**	Unsatisfactory	No opinion
Help for troubleshooting	**S, I[1], I[1], I[1]**	**Satisfactory**	**Intermediate**	Unsatisfactory	No opinion
Readability / Clarity of presentation	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
General impression	**S, S, S, S**	**Satisfactory**	Intermediate	Unsatisfactory	No opinion
Measurement principle	**S**	**Satisfactory**	Intermediate	Unsatisfactory	
Available insert in Danish, Norwegian, Swedish	**S**	**Satisfactory**	Intermediate	Unsatisfactory	
Total rating by SKUP		**Satisfactory**			

[1]Limited information regarding the error messages and limited descriptions on potential problems. Not easy to understand whether the error messages refer to user errors or technical errors.

Table C. Rating of time factors (filled in by SKUP)

Topic	Rating	Rating	Rating
Required training time	**<2 hours**	2 to 8 hours	>8 hours
Durations of preparations / Pre-analytical time	**<6 min.**	6 to 10 min.	>10 min.
Duration of measurement	**<20 min.**	20 to 20 min.	>0 min.
Stability of test, unopened package	>5 months	**3 to 5 months***	<3 months
Stability of test, opened package	**>30 day or disposable**	14 to 30 days	<14 days
Stability of quality control material, unopened	>5 months	**3 to 5 months***	<3 months
Stability of quality control material, opened	**>6 days or disposable**	2 to 6 days	≤1 day
Total rating by SKUP	**Satisfactory**		

*According to the manufacturer, the stability may be prolonged when the product has existed longer.

Additional positive comments:
It is a great advantage that the extraction buffer including specimen is stable for up to five hours when contact tracing many people during a Covid-19 outbreak.

Table D. Rating of analytical quality control (filled in by SKUP)

Topic	Rating	Rating	Rating
Reading of the internal quality control	**Satisfactory**	Intermediate	Unsatisfactory
Usefulness of the internal quality control	**Satisfactory**	Intermediate	Unsatisfactory
External quality control	**Satisfactory**	Intermediate	Unsatisfactory
Total rating by SKUP	**Satisfactory**		

6.4.2. Assessment of the user-friendliness

Assessment of the operation facilities (table A)
The operation facilities were overall assessed as satisfactory, but there were several intermediate ratings that should be addressed. The intermediate ratings mainly concerned the sources of technical errors. The instrument logs reveal that the number of errors were under-reported by the operators, hence only 3,3 % were counted as technical errors. This is still above SKUP's recommendations for the fraction of tests wasted due to technical errors. According to the manufacturer, some of the reported system errors were eliminated from instruments produced from October 2020 onwards.

Assessment of the information in the manual (table B)
The manual was assessed as satisfactory, but there were intermediate rating concerning use of the manual for troubleshooting and not being able to find a solution. A list of error codes is highly recommended.

Assessment of time factors (table C)
The time factors were assessed as satisfactory.

Assessment of analytical quality control possibilities (table D)
The analytical quality control possibilities were assessed as satisfactory.

Conclusion
In all, the user-friendliness of LumiraDx SARS-CoV-2 Ag Test and its manual was rated as satisfactory, although there is improvement potential pointed out. The quality goal for user-friendliness was fulfilled.

7. References

1. Chan JF. *et al.* A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet 2020; **395**: 514 – 523.
2. WHO. Antigen-detection in the diagnosis of SARS-CoV-2 infection using rapid immunoassays, Interim guidance, 11 September 2020, https://www.who.int/publications/i/item/antigen-detection-in-the-diagnosis-of-sars-cov-2infection-using-rapid-immunoassays. (accessed 2020-09-21).
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4. The IFCC – IUPAC terminology for properties and units. http://www.ifcc.org/ifcc-scientific-division/sd-committees/c-npu/npusearch/ (accessed 2020-09-23).
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6. He X., Lau E.H.Y., Wu P. et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nat Med 26, 672–675 (2020).
7. Norwegian Directorate of Health. COVID-19 pandemic: Evaluation of Abbot's Panbio COVID-19 rapid antigen test in Norway, December 2020, https://www.helsedirektoratet.no/tema/beredskap-og-krisehandtering/koronavirus (accessed 2020-12-29).

Attachments

1. The organisation of SKUP
2. Facts about LumiraDx SARS-CoV-2 Ag Test
3. Information about manufacturer, retailers and marketing
4. Product specifications for this evaluation, LumiraDx SARS-CoV-2 Ag Test
5. Statistical expressions and calculations
6. Raw data, internal analytical quality control results, LumiraDx SARS-CoV-2 Ag Test
7. Raw data, LumiraDx SARS-CoV-2 Ag Test and the comparison method
8. Comments from LumiraDx AS

Attachments with raw data are included only in the copy to LumiraDx AS.

The organisation of SKUP

Scandinavian evaluation of laboratory equipment for point of care testing, SKUP, is a co-operative commitment of DEKS[1] in Denmark, Noklus[2] in Norway and Equalis[3] in Sweden. SKUP was established in 1997 at the initiative of laboratory medicine professionals in the three countries. SKUP is led by a Scandinavian *steering committee* and the secretariat is located at Noklus in Bergen, Norway.

The purpose of SKUP is to improve the quality of near patient testing in Scandinavia by providing objective and supplier-independent information about analytical quality and user-friendliness of laboratory equipment. This information is generated by organising SKUP *evaluations*.

SKUP offers manufacturers and suppliers evaluations of laboratory equipment for point of care testing. Provided the equipment is not launched onto the Scandinavian market, it is possible to have a confidential pre-marketing evaluation. The company requesting the evaluation pays the actual testing costs and receives in return an impartial evaluation.

There are *general guidelines* for all SKUP evaluations and for each evaluation a specific *SKUP protocol* is worked out in co-operation with the manufacturer or their representatives. SKUP signs *contracts* with the requesting company and the evaluating laboratories. The analytical results are assessed according to *pre-set quality goals*. To fully demonstrate the quality of a product, the *end-users* should be involved in the evaluations.

Each evaluation is presented in a *SKUP report* to which a unique *report code* is assigned. The code is composed of the acronym SKUP, the year the report was completed and a serial number. A report code, followed by an asterisk (*), indicates an evaluation with a more specific objective. The asterisk is explained on the front page of these protocols and reports.

SKUP reports are published at www.skup.org.

[1] DEKS (Danish Institute for External Quality Assurance for Laboratories in Health Care) is a non-profit organisation owned by the Capital Region of Denmark on behalf of all other Regions in Denmark.

[2] Noklus (Norwegian Organization for Quality Improvement of Laboratory Examinations) is a national not for profit organisation governed by a management committee consisting of representatives from the Norwegian Government, the Norwegian Medical Association and the Norwegian Society of Medical Biochemistry, with the Norwegian Association of Local and Regional Authorities (KS) as observer.

[3] Equalis AB (External quality assessment in laboratory medicine in Sweden) is a limited company in Uppsala, Sweden, owned by “Sveriges Kommuner och Regioner” (Swedish Association of Local Authorities and Regions), “Svenska Läkaresällskapet” (Swedish Society of Medicine) and IBL (Swedish Institute of Biomedical Laboratory Science).

Facts about LumiraDx SARS-CoV-2 Ag Test

This form is filled in by LumiraDx AS.

Table 1. Basic facts

Name of the measurement system:	LumiraDx Platform Instrument
Dimensions and weight:	Width: 97 mm Depth: 210 mm Height: 73 mm Weight:1100g
Components of the measurement system:	LumiraDx Platform Instrument and Teststrips
Measurand:	Qualitative detection of the nucleocapsid protein antigen to SARS-CoV-2
Sample material:	Nasal and nasopharyngeal swab specimen
Sample volume:	One drop
Measuring principle:	Microfluidic immunofluorescence assay
Traceability:	n/a
Calibration:	Lot Calibration File
Measuring range:	Qualitative
Haematocrit range:	n/a
Measurement time:	12 mins
Operating conditions:	15°C and 30°C (59°F and 86°F), and at a relative humidity between 10 % and 90 % (non-condensing) stable surface
Electrical power supply:	Input 100-240V / 50-60 Hz / 1.0 – 0.5A Output 12V / 3A and batteries Lithiumionpolymer 7,4 V / 5000 mAh
Recommended regular maintenance:	The LumiraDx Instrument does not require user maintenance and has no serviceable parts. The following parts of the Instrument can be cleaned and/or disinfected: • The area around the Test Strip slot • The entire Instrument housing • The Instrument touch screen • All surfaces of the Instrument door
Package contents:	The LumiraDx Instrument package includes the following contents: 1. LumiraDx Instrument 2. LumiraDx Power Supply Unit 3. Platform User Manual 4. Platform Quick Reference Guide (including passwords for Standalone operation)
Necessary equipment not included in the package:	Swabs for sampling

Table 2. Post analytical traceability

Is input of patient identification possible?	YES
Is input of operator identification possible?	YES
Can the instrument be connected to a bar-code reader?	YES
Can the instrument be connected to a printer?	YES
What can be printed?	Patient and QC tests result can be printed from the Instrument result page following a test, or from the test details page in the Instrument Result History.
Can the instrument be connected to a PC?	YES
Can the instrument communicate with LIS (Laboratory Information System)? If yes, is the communication bidirectional?	YES YES
What is the storage capacity of the instrument and what is stored in the instrument?	1000 test results with date, time and comments Lot calibration files
Is it possible to trace/search for measurement results?	YES

Table 3. Facts about the reagent/test strips/test cassettes

Name of the reagent/test strips/test cassettes:	LumiraDx SARS-CoV-2 Ag Test
Stability in unopened sealed vial:	4 months (will be prolonged when the product have existed longer)
Stability in opened vial:	After removing the Test Strip from the foil pouch, it should be used immediately.
Package contents:	LumiraDx Test Strips packed individually in sealed desiccant foil pouches. • LumiraDx Test Product Insert • RFID (Radio frequency ID) Tag held inside the Test Strip carton • Extraction Buffer Vials • Dropper Lids

Table 4. Quality control

Electronic self check:	Yes
Recommended control materials and volume:	LumiraDx SARS-CoV-2 Ag Quality Controls, 20 µl
Stability in unopened sealed vial:	4 months (will be prolonged when the product have existed longer)
Stability in opened vial:	Once opened, the vial has a 30-day expiry.
Package contents:	2 x 0.5ml vial SARS-CoV-2 Ag Positive Control • 2 x 0.5ml vial SARS-CoV-2 Ag Negative Control • 24 Transfer pipettes (20µl) • LumiraDx SARS-CoV-2 Ag Quality Control Pack Insert

Information about manufacturer, retailers and marketing

This form is filled in by LumiraDx AS.

Table 1. Marketing information

Manufacturer:	LumiraDx UK Ltd Dumyat Business Park, Alloa FK10 2PB, UK 00800 58647239 customerservices@lumiradx.com www.lumiradx.com
Retailers in Scandinavia:	Denmark: LumiraDx A/S Postboks 24 DK - 4700 Naestved Norway: LumiraDx AS Postboks 70, 2001 Lillestrøm Sweden: LumiraDx AB Västra Vägen 5A, BV 169 61 Solna
In which countries is the system marketed:	Globally ☒ Scandinavia ☐ Europe ☐
Date for start of marketing the system in Scandinavia:	November 2020
Date for CE-marking:	2020.08.28 (Ag test)
In which Scandinavian languages is the manual available:	Norwegian, Sweden, Danish

Product specifications for this evaluation, LumiraDx SARS-CoV-2 Ag Test

LumiraDx instruments, REF. L002010307001

Instrument	**Serial no**
1	30874-20-34-06459
2	30874-20-33-06461
3 (spare)	30874-20-34-06808
4 (demo from LumiraDx AS)	30874-20-34-06829
5 (from LumiraDx AB)	30874-20-41-10802
6 replacement	30874-20-38-08193
7 replacement	30874-20-42-11763
8 replacement	30874-20-43-11954
9 replacement	30874-20-43-11962

LumiraDx test strips, REF. L016000101048

Lot name in evaluation	**Lot no**	**Expiry date**
a	5000163	2020-12-31
b	5000169	2021-01-02
c	5000175	2021-01-07

LumiraDx SARS-CoV-2 internal analytical quality liquid controls, REF. L01608101002

Control kit	**Lot no**	**Expiry date**
Controls, negative and positive	GM2000086 GM2000109	2021-03-01 2021-03-01

Other equipment used in the evaluation

Equipment	**Lot no**	**Expiry date**
For nasal specimen; FLOQswabs CLASSIQ Copan REF: 502CS01	Z6C350C8	2024-04-30
For nasopharyngeal specimen; Dryswab CNWE REF: MW813	Lot 20H06	2025-08

Statistical expressions and calculations

This attachment is valid for evaluations of qualitative test methods with results on the ordinal scale.

Statistical terms and expressions

The definitions and formulas in this section originate from the Geigy document [a].

Statistical calculations

Diagnostic sensitivity is true positive/(true positive + false negative)

Diagnostic specificity is true negative/(false positive + true negative)

Positive predictive value (PPV) is true positive/(true positive + false positive)

Negative predictive value (NPV) is true negative/(true negative + false negative)

Prevalence is true positive/(true positive + true negative + false positive + false negative)

See table 1 for an illustration.

Table 1. Illustration of statistical calculations

	Truth		
	Positive	**Negative**	
Evaluated test positive	a	b	PPV = a/(a+b)
Evaluated test negative	c	d	NPV = d/(d+c)
	Diagnostic sensitivity = a/(a+c)	Diagnostic specificity = d/(b+d)	

Calculation of confidence intervals

Estimation of CI for fractions/proportions is performed according to Adjusted Walds [a]. The confidence intervals (CIs) are given for information only.

Relationship between PPV / NPV and prevalence

Contrary to diagnostic sensitivity and specificity, the PPV and NPV are related to the prevalence of the disease in a specific population (figure 1). PPV and NPV are also related to the diagnostic sensitivity and specificity of a diagnostic test.

a. http://www.measuringu.com/wald.htm

Comments from LumiraDx AS

SKUP
Boks 6165
5892 Bergen Norway
January 10th, 2021

Ref: Comments on the SKUP Evaluation Report on LumiraDx SARS-CoV-2 Ag Test

Dear Ladies and Gentlemen,

LumiraDx would like to thank SKUP for their comprehensive evaluation and thorough report of the LumiraDx SARS-CoV-2 Ag Test on the LumiraDx Platform. The aim of the evaluation was to assess the diagnostic performance and user-friendliness of LumiraDx SARS-CoV-2 Ag Test when used under real life conditions by intended users in a dedicated Covid-19 testing centre. We are very pleased with the performance data that has been achieved in the hands of real users of the Instrument.

We are very happy, and not at all surprised with the attainment of the highest rating for the user-friendliness Quality Goal. The Ease of use with our Instrument and associated Test strips is always a key priority, and we have focused on this during the design and development process at LumiraDx.

Whilst the percentage of tests wasted was slightly above the SKUP recommendation of ≤2 % tests, we are pleased to see that the Error code functionality provided clear feedback during the testing and served its function to prevent inaccurate test results due to invalid test process, or user errors. The integrated connectivity function that is built into the LumiraDx Instrument, means that immediate feedback can be provided irrespective of the customers location across the world.

Finally, we would like to thank SKUP for their collaborative approach during the evaluation process – and their rapid response and turnaround of this report during a very busy time. We are grateful to the whole team at SKUP for their endeavours.

Yours sincerely,

Dr Nigel Lindner
Chief Innovation Officer & Head of Care Solutions

LumiraDx UK Limited, 3 More London Riverside, London, United Kingdom