

VIRTUAL INNOVATION SPOTLIGHT

X-RAY & AI FOR RAPID TB & COVID-19 SCREENING DELFT IMAGING APRIL 22, 2020 4:00-5:00 PM (CEST)

QUESTIONS & ANSWERS SUMMARY¹

A. Cost & pricing

1. What is the cost of the light portable x-ray backpack?

The cost of the Delft Light is approximately EUR 75,000 for one unit. Discounts are applicable in case multiple costs are procured, or in combination with other goods and services offered by Delft Imaging (including mobile clinics and/or the CAD4TB software).

2. Are there cost reductions for those purchasing from low-income countries? Are there any tax reductions?

CAD4COVID (AI for COVID-19 triage) is available free-of-charge in support of the crisis. For our other goods (like x-ray systems, mobile clinics and the CAD4TB software) we do not have generally applicable access pricing structures. However, we review inquiries from customers on a case-by-case basis and discounts can be applicable depending on the type and/or size of the project.

3. Does Delft offer different pricing structures?

Mobile clinics and x-ray systems can be procured on a per unit basis. The CAD4TB AI software is costed on a per-reading basis, where bundles of readings are procured depending on the amount of people to be screened (e.g., a program screening 50,000 people would require a bundle of 50,000 CAD4TB readings).

Incidentally, we also offer leasing options for the goods we offer that would normally be procured per unit.

B. Technical

1. What is the correlation between TB and COVID-19 on chest x-rays?

TB related abnormalities are mostly in the upper part of the lungs, COVID-19 in the lower part. That said there will always be some overlap in abnormalities but both AI packages will be continuously further improved to detect the specific diseases by adding more PCR confirmed TB and/or COVID cases.

2. Can Delft's solution also screen for pneumoconiosis (i.e., silicosis)?

We indeed also have an AI solution for the detection of silicosis, called CAD4Silicosis. Please email info@delft.care for more information.

¹ Note: The questions were submitted from participants who attended the Virtual Innovation Spotlight and the answers were provided by Delft Imaging.

3. Can Delft's solution detect the early infection of TB, perhaps at two weeks?

If there is an abnormality visible in the chest -ray, CAD4TB will pick this up.

4. How can we address the challenge of using the CAD score to triage patients to GeneXpert test?

The higher the cut-off (threshold) score the more specific the system will be which means more presumptive TB cases will be bacteriological confirmed. This comes at a price of losing sensitivity so you will not find every TB case in such an approach. Vice versa, the lower the score the higher the sensitivity at a cost of losing specificity. For further information on this topic, please also read: "Automated Chest-Radiography as a Triage for Xpert Testing in Resource-Constrained Settings: a Prospective Study of Diagnostic Accuracy and Costs, Scientific Reports, Volume 5. P. 12215, 2015."

5. Is the CAD score threshold for TB similar for COVID-19?

No, these are separate solutions. However, the same triage 'rule' applies: the higher the cut-off the more specific the output will be and the lower the cut-off the more sensitive it will be.

6. Does Delft's solutions clearly differentiate between TB and COVID-19? What are the differing characteristics?

CAD4TB and CAD4COVID are two different systems hence the output is also different. Furthermore, CAD4COVID also gives an additional score which is a measure of the affected lung area.

7. Will Delft's solutions be able to screen TB patient affected with COVID-19? If yes, is there any literature available on this?

They are separate solutions. Additional research needs to be done regarding possible screening protocols for screening for both TB and COVID-19.

8. Compared to TB, why is the COVID-19 sensitivity is less?

Like CAD4TB, CAD4COVID sensitivity is based on a chosen cut-off.

9. Is there a CXR bank for COVID-19 confirmed cases that you can further train the AI for COVID-19?

There is no (global) CXR bank for COVID-19 confirmed cases at this moment.

10. How soon after infection with COVID-19 do changes appear on the chest radiographs?

That differs from patient to patient. Some patients even, do not show any abnormalities on the CXR at all. To our knowledge, there is currently no literature available on that.

11. Can the TB and COVID-19 solution be combined to differentiate TB, COVID-19, normal or any other abnormality?

Yes, in theory this would be possible.

12. What are the distinguishing characteristics between TB and COVID-19 in AI?

TB related abnormalities are mostly in the upper part of the lungs, COVID-19 in the lower part. That said there will always be some overlap in abnormalities but both AI packages will be continuously further improved to detect the specific diseases by adding more PCR confirmed TB and/or COVID cases.

13. Does the x-ray image quality impact the sensitivity of CAD4COVID?

As the x-ray image is the input of the CAD4COVID software, its quality will impact the output of CAD4COVID as well. Lower quality images could potentially negatively impact the sensitivity of AI software like CAD4COVID.

14. Should there be a demand for a global solidarity COVID x-ray and CT-scan image bank for quick machine learning? If successful can be extended later to TB and other respiratory illnesses.

There are currently a number of conversations taking place on this topic, both on a global level but also within the European Union specifically. A central image bank could indeed be helpful, although it is worth noting that when training AI models the quality of the data is as least as important as the quantity; it would be very important to safeguard the quality of the data.

15. What are the implications for use of x-rays and CAD4COVID as a measure of disease progression?

CAD4COVID reflects a COVID-19 probability score, a heatmap, and also the percentage of visible lung tissue affected. The latter is helpful in measuring disease progression and recovery as we are able to quantify the affected lung tissue.

16. How about the use of dual energy to improve CXR image quality?

We have previously done some initial work on the use of dual energy, but at that point did not see much improvement.

17. Can the same x-ray image picture (for the same patient) be analyzed by both the CAD4TB and CAD4COVID software? Can we get two heat maps from one x-ray?

Yes.

18. Can CAD4COVID be used on the different versions of the digital x-rays if a country procured the x-ray equipment at different times?

Definitely. CAD4COVID uses DICOM Images as input, regardless from the (version) of digital x-ray system that is being used.

19. Are lateral view also available for analysis?

At this moment, only PA/AP views are available for analysis.

C. Scale-up and implementation

1. How far down the line are you with getting CAD4COVID endorsed by the likes of WHO, CDC, etc.?

The application of AI in the detection of COVID-19 (on both x-ray and CT, but especially on x-ray) is still relatively new.

Our scientific study (presented in the VIS organised by the Stop TB Partnership and paper is under review at *Radiology Journal*) showed CAD4COVID performs on a similar level as radiologists. It is the first study to demonstrate the performance of an AI system to detect abnormalities related to COVID-19 on chest radiographs on an independent test-set and compare it to expert readers. Further validation, both practical validation in the field and scientific validation should still be conducted on not only artificial intelligence, but the role of X-ray in COVID-19 detection in general.

2. What kind of training/skill is required to read the result? Who can operate the machine? Can health workers (not a doctor) with basic knowledge on TB can read/use the machine/result?

CAD4TB and CAD4COVID are usually operated by radiographers or radiologists that interpret chest x-ray images in the field as well. Both CAD4TB and CAD4COVID are support tools to healthcare specialists to help them interpret the result.

3. How can country programmes and providers access the technical expertise to service the machine?

CAD4TB and CAD4COVID are AI software modules to which DICOM images of TB or COVID-19 can be uploaded. These images would come from your existing X-ray machine; no additional machine is required. For CAD4TB, we normally provide in-country training to help with capacity building regarding the use of the software. Considering the travel limitations because of the COVID-19 pandemic, support will be provided through manuals and webinar sessions if needed.

4. Can country programmes and providers update to the latest version of Delft's solution once they start using it? Is there a need for software upgrading or any other equipment?

There is no need to update or upgrade any other equipment. Country programs and providers that use CAD4TB or CAD4COVID will always be given access to the latest updates of the software.