Protocols of reactive screening of the class after the detection of a case in the primary school

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These protocols are compared to the protocols presented in the following preprint [1]:

Colosi et al. *Self-testing and vaccination against COVID-19 to minimize school closure*
https://www.medrxiv.org/content/10.1101/2021.08.15.21261243v1

Epidemic context and vaccination scenario. We considered the epidemic scenario presented in the preprint [1] characterized by an effective reproductive number R=1.3, 25% natural immunity in the population, 50% of vaccinated teachers (analyses performed in the preprint show that fully vaccinating teachers does not alter the study conclusions). Children in primary school are not yet eligible for vaccination. Introductions in the school settings were estimated from the community prevalence [2] and fixed to one introduction every two weeks, approximately corresponding to the value estimated in January-February 2021 in France. Currently, importations are expected to be higher, but we kept the same importations of the study [1] for the sake of comparison.

Testing and isolation protocols. As in the preprint, *Symptom-based testing and case isolation (ST)* is considered as the basic strategy, present in all protocols, and against which interventions are evaluated. It considers that clinical infections are detected with the estimated probability and tested; if the result is positive, the case is isolated for 7 days. In the preprint we tested the following intervention protocols:

- *Reactive quarantine of the class (ST+Qc):* once a case is identified through ST, their class is put in quarantine for 7 days. If quarantined individuals develop symptoms, they remain in isolation for an additional period of 7 days, before returning to school. This protocol is close to the one in place in France before regular testing was deployed.
- *Reactive quarantine of the class level or specialization (ST+Ql):* as the previous protocol, but quarantine is applied to the classes of the same level (2 classes in the primary school).
- *Regular testing with α adherence (ST+RTα%):* in addition to symptom-based testing, regular testing is offered to the school and performed at a certain frequency (once every two weeks, once or twice per week). We considered that only a certain percentage α of the school population will participate to regular testing. Detected cases are isolated without triggering any class closure.

In addition to those, we introduced here the following reactive protocols:

- *Reactive screening of the class after the detection of a case (+1d from detection), considering a participation of a percentage γ of individuals (ST+RSγ%):* in addition to symptom-based testing, reactive screening of the class is implemented every time a case is identified through ST. We considered that only a certain fraction γ of the class will adhere to screening the day after the detection of a symptomatic case (γ=50% and 100%). Detected cases are isolated without triggering any class closure. Reactive screening is performed only during school days (i.e., if a case is detected on Friday, the reactive screening occurs on the following Monday, as we assume it is performed at school).
- *Reactive screening of the class after the detection of a case (+1d from detection), followed by a control test 3 days after (+4d from detection), considering a participation of a percentage γ of individuals (ST+RS+CTγ%):* as above, with an additional testing 3 days after the first reactive screening for control of possible infections that went undetected in the first screening. This is performed on the class of the detected case, assuming that the same individuals who underwent the reactive screening would be tested again. Adherence is fixed to γ=50% and 100% as above. Detected cases are isolated without triggering any class closure. Both screenings (the reactive screening and the control one) are performed only during school days.

We used the same parameterization used in the preprint for the sake of comparison, considering PCR testing from saliva samples in the primary school (test sensitivity of 70% in the prodromal phase, 80% in the subclinical phase, and 90% in the clinical phase [3], with a result available after 24h).

RESULTS AND IMPLICATIONS

Regular testing remains the most efficient protocol for preventing infections and reducing the number of student-days lost. With 50% of adherence, regular testing would reduce the number of cases by ¼ with a weekly frequency and by 1/3 with a bi-weekly frequency (ST+RT50% in Figure 1a). These values are obtained considering children to be 50% susceptible compared to adults and less infectious; higher values are obtained considering homogeneous susceptibility across age classes (for details, see [1]).

Reactively closing the class after detecting a case based on symptoms (ST+Qc) would provide little advantage in preventing cases (<10% case reduction compared to the basic strategy) and it would largely increase the number of missed days (Figure 1b). A small improvement in case reduction is found if multiple classes are closed, of the same level of the class of the detected case (ST+Ql). This is due to the higher mixing empirically observed across individuals of the same school level, i.e. of the same age. This measure, however, inevitably increases further the number of school days lost (Figure 1b).

If reactive screening replaces class closure after the detection of a case, similar results are obtained in the reduction of cases, even considering that all individuals participate (ST+RS50%, ST+RS100%, green symbols in Figure 1a). Days lost, instead, would be similar to the basic strategy ST, as few cases would be identified through this protocol (Figure 1b). An additional control test performed 3 days after the reactive screening would not provide additional benefit (ST+RS+CT50%, ST+RS+CT100%, yellow symbols in Figure 1a).

Reactive protocols (either by closing the class or by testing the class) perform poorly in infection prevention due to their strong reliance on symptomatic detection, which allows asymptomatic COVID-19 forms to silently spread the infection. This is particularly problematic in primary schools, where the majority of infections are asymptomatic. Also, numerical results show that there is a rather large probability that additional classes have active infections by the time a case is detected in a class because of silent propagation and/or importations from the community (Figure 2). The advantage of reactive screening compared to reactive class closure lies in the lower number of days lost. However, this results from the inability of the protocol to detect cases (therefore few students are put in isolation) and reduce the viral circulation at school. In other words, this corresponds to leave the virus to circulate almost freely in the school setting. Testing 3 days after the reactive screening would not provide a supplementary benefit, as few additional cases may be found, but the measure would not be enough to prevent importations or transmissions to other classes. Even extending the test to the entire school would require testing with a high frequency in order to (i) detect infections that would otherwise be unobserved, (ii) detect infections that were not yet detectable at the previous screening, because of the sensitivity of the test and the progression of the infection in the individual, (iii) detect importations of cases from the community. Repeating the control test until no cases are found would effectively approach a regular testing protocol.

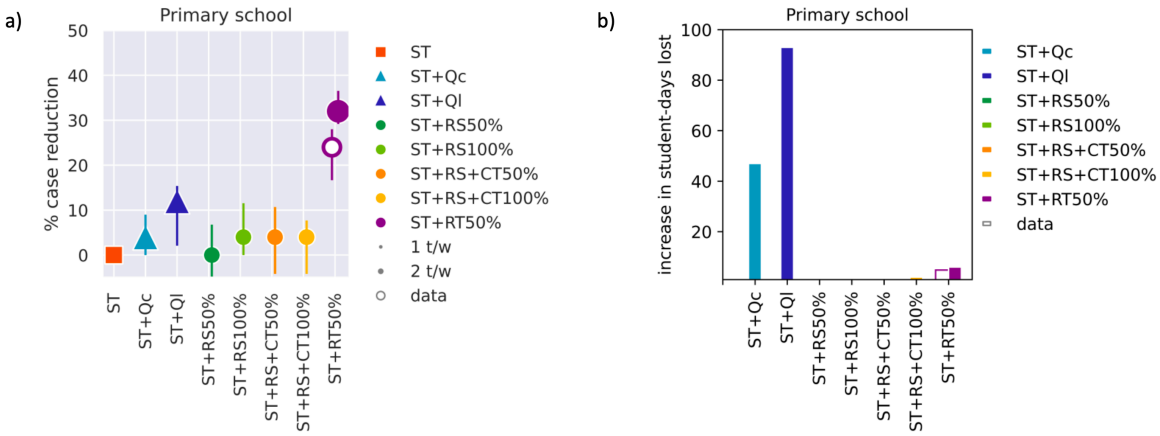

Figure 1. Efficiency and cost-benefit of regular testing in primary school. (a) Predicted percentage of reduction in the number of cases achieved by each intervention protocol with respect to the basic strategy of the symptom-based testing (ST) in the primary school. Intervention protocols are: symptom-based testing and case isolation, with reactive quarantine of the class (ST+Qc); symptom-based testing and case isolation, with reactive quarantine of the class level (ST+Ql); symptom-based testing and case isolation, coupled with reactive

screening (+1d from detection) on a γ fraction of the class with a symptomatic case (ST+RSγ%), with γ=50% and 100%; symptom-based testing and case isolation, coupled with reactive screening (+1d from detection) on a γ fraction of the class with a symptomatic case followed by a control test (+4d from detection) (ST+RS+CTγ%), with γ=50% and 100%; symptom-based testing and case isolation, coupled with regular testing with 50% adherence and a weekly (smaller circle on the left) or biweekly (larger circle on the right) frequency. Error bars correspond to 95% confidence intervals. (b) Predicted increase in student-days lost with respect to symptom-based testing (ST) for different protocols in the primary school. For the regular testing, the left bar corresponds to weekly testing, the right bar to bi-weekly testing. In both panels, the empty markers correspond to the adherence estimated from empirical data recorded in primary schools during the third wave in France [1].

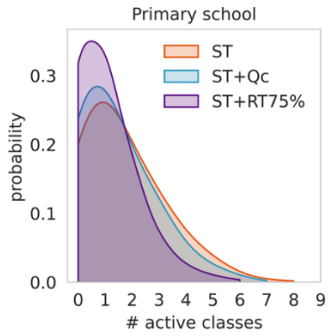

Figure 2. Additional active classes, i.e. classes with an active infection at the time a case is detected. Smoothed probability distribution of the number of classes in which there is at least one active infection when a symptomatic case is confirmed. Selected protocols are shown for the primary school: symptom-based testing (ST); symptom-based testing and case isolation, with reactive quarantine of the class (ST+Qc); symptom-based testing and case isolation, coupled with weekly regular testing with 75% of adherence (ST+RT75%).

[1] "Self-testing and vaccination against COVID-19 to minimize school closure | medRxiv." https://www.medrxiv.org/content/10.1101/2021.08.15.21261243v1 (accessed Aug. 31, 2021).

[2] L. Di Domenico, E. Valdano, E. Colosi, and V. Colizza, "Risk of COVID-19 introductions in schools in France week 37 (Sept 7-13, 2020)," Sep. 2020. [Online]. Available: http://www.epicx-lab.com/uploads/9/6/9/4/9694133/risk_of_introduction_at_school.pdf

[3] ECDC, "Considerations for the use of saliva as sample material for COVID-19 testing," European Centre for Disease Prevention and Control, May 2021. [Online]. Available: https://www.ecdc.europa.eu/sites/default/files/documents/covid-19-use-saliva-sample-material-testing.pdf