Should air cleaners be deployed in schools?

The popularity of air-cleaning technology has increased in recent years (Siegel, 2016), even more so since the COVID-19 pandemic (SAGE, 2020). A Google search reveals that numerous air-cleaning devices (ACDs) are available, with differences in shape, size and cost (Rawat and Kumar, 2023). However, these instruments remain largely unregulated and deciding which, if any, ACD to use is challenging. Schools face a particular challenge, as they try to balance the efficacy and safety of the ACDs, the benefits to children's health through using them and the financial costs.

ACDs tend to adopt one or more techniques, including thermal or photocatalytic oxidation, adsorption, filtration, UV germicidal irradiation, ion generation, and electrostatic precipitation (Zhang *et al.*, 2011). However, none of these technologies remove all of the indoor air pollutants present and many generate undesirable secondary products (Zhang *et al.*, 2011; US EPA, 2018; Zaatari et al., 2021).

The recent SAGE Environmental Modelling Group report noted that '*ACDs have limited benefit in spaces that are already adequately ventilated, and are not necessary for adequately ventilated buildings unless there are identified specific risks*'. The SAGE group further suggested that if ACDs were required, those which used filtration or germicidal UV were likely to be beneficial **if** deployed correctly.

Our TAPAS (Tackling Air Pollution At Schools) network comprises stakeholders across academia, education, public policy, civil society and business (TAPAS, 2022). We work together to support the development of healthy schools by improving air quality. This short note highlights some of the major areas that we think should become a focus for policy development around ACD use in schools. Our thoughts have been informed through literature reviews and a recent TAPAS meeting on this topic.

1. **Introduce regulation of ACDs**. A new statutory requirement for the testing of ACDs by an accredited organisation will ensure objective assurance of safety and efficacy of devices, rather than being reliant on data from companies themselves. Such testing would need to be carried out in realistic environments (not in carefully controlled laboratories), over a range of temperatures, humidities, and with different background concentrations of air pollutants. It also needs to consider the ability of ACDs to impact concentrations of both biological **and** chemical pollutants. We have talked to responsible manufacturers who would welcome such a move, given the current tendency for purchasing of ACDs to be driven mainly by cost. The accreditation procedure would need to ensure that the ACD was safe to use **and** maintain into the future as the ACD ages.

   Along with the requirement for regulation, we believe that manufacturers should provide the ACD operating parameters (noise levels, maintenance regime costs, efficiency of removal of key pollutants for specific concentration ranges) in a

standardised format such as a checklist, so that schools can compare different makes and models against efficacy, running and maintenance costs, and unit price. Even better, there could be a regulated marketplace for the ACDs, potentially approved by the DfE.

2. **Guidance on the requirement for an ACD**. Well ventilated spaces will not need an ACD unless there are specific identified risks, such as a busy road outside (SAGE, 2020). Some schools may be unable to open windows and have little choice but to adopt ACDs to clean indoor air. Many schools were given carbon dioxide (CO_2) monitors during the height of the covid pandemic. Deciding whether air cleaning is needed could be linked to the CO_2 concentrations recorded by these monitors. A priority could be to deploy them in schools where the CO_2 concentration is consistently above 1500 ppm for instance. Such a level would indicate that ventilation is generally poor (SAGE, 2021).

   Schools in different types of locations may have different air cleaning needs. Those near busy roads will need to reduce e.g. particulate matter ingress from outdoors. Schools in suburban and rural areas may be further from roadside pollution, but may be subject to the ingress of regional pollutants such as ozone, particularly in the spring and summer. Clearly, schools and, indeed individual classrooms and other spaces, should be considered on an individual basis, and a holistic approach used to deploy an appropriate ACD if needed, once the indoor and outdoor air quality regime is understood.

   There may also be a need to rank pollutants for removal, depending on their typical concentrations at a school, versus the known health effects. Filtration devices are good at removing PM, but not as good at removing gas-phase pollutants (SAGE, 2020). However, if PM are the biggest health concern at a particular location, filtration may be the best option, as schools are unlikely to have the funds or space to operate a range of different ACDs for numerous classrooms.

   For mechanically ventilated schools, there will be the option to incorporate air cleaning into the existing ventilation system, rather than purchasing individual units. However, retrofitting such systems is often expensive and disruptive, particularly at a time when schools face hard choices about how to spend limited funds. It is possible that individual ACD units may be attractive in such cases.

3. **Guidance on operating an ACD**. Consideration will need to be given to where the ACD is to be installed and what the space and noise requirements are in that space. An ACD operating in an underground car park will be able to operate under different parameters to those needed in a classroom. We have heard anecdotally, that ACDs are often turned down or off in classrooms, as they are too noisy during operation when a classroom is being used.

Ideally, operation and maintenance of these devices should be as simple as possible, with little to no onus on the operator to interpret readings and make decisions about operating conditions thereafter. ACD suppliers should offer a training package and sufficient guidance and support following installation for users to competently use the relevant technology. It would also be useful to have preliminary support to identify the best place for an ACD within a room, given the user needs and operating conditions. For instance, a recent study found that placing ACDs within polluted zones in a room yielded the maximum reductions (Kumar et al., 2023). A well-considered set-up process is therefore essential, including ensuring sufficient space for intake air for the ACD and avoiding proximity to air outlets.

ACDs need to be big enough to provide the required flow of clean air, given the characteristics of the room in question. For instance, a recent study found that doubling the flow capacity of an ACD does not lead to a doubling in the PM_{10} concentration reduction (Kumar et al., 2023). Linking back to regulations, the CADR (Clean Air Delivery Rate) is more critical than the flow rate and users should be made aware of the difference between the two. Particularly in the school setting, trip hazards from cables need to be avoided.

We note that the DfE recently (November) made advice concerning ACDs available to schools, in a document entitled '*How to' Use air cleaning units in education and childcare settings*' (DfE, 2022). The advice presumes that school managers know (i) when a school's ventilation is inadequate; (ii) what remedial work might be necessary to address inadequate ventilation; and (iii) whether a particular ACD is suitable for their building. The section on selecting an ACD lists some factors to consider, but again, the onus is on the school to decide what to do.

Finally, ACDs are only an interim solution for poor indoor air quality in classrooms. The need to use them is because of failing ventilation provision, whether through poor design or operation. For most classrooms, the appropriate longer-term solution is to clean up the air outside schools and make sure that all classrooms have adequate window openings to provide ventilation that is needed. Encouraging classroom staff to appropriately adopt, and use, the CO_2 monitors provided by the DfE is also a crucial step in schools striking a balance in wintertime between ventilation and energy usage – anecdotally, this remains a challenge in most schools.

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