# Dry heat inactivation of pathogens in dryer cabinet assessed by modelling

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# 1 Summary

Children get viral and bacterial infections whether or not they facilitate childcare centres. However, young children and infants that attend childcare have an increased rate of certain infectious disease and importantly also an increased risk of acquiring antibiotic-resistant bacteria [1-3]. The most frequently encountered infectious microorganisms in childcare environments are the respiratory tract and enteric pathogens [4-6]. Prevention of transmission of such pathogens among children in childcare settings is a priority, especially since it also significantly impacts childcare workers, families, close relatives, as well as the society [4, 7-10].

Pathogenic microorganisms on hands, surfaces and fabrics such as clothes, towels and linen have been associated with increased risk of acquiring infections and infectious diseases in children [11, 12]. Hence, control strategies applied in childcare centres that significantly reduce the burden of pathogens that occur on hands, surfaces and fabrics have the potential to reduce transmission of infectious diseases [3, 13, 14].

This report provide a theoretical risk assessment regarding pathogenic viruses and non-spore-forming bacteria within the context of dry heat treatment of contaminated cotton towels used by children in childcare centres as blankets. This report also models thermal inactivation of two pathogenic viruses and one pathogenic bacteria by heat generated in a drying cabinet manufactured by Nimoverken AB. The main purpose of the risk assessment is to provide Nimoverken AB with scientific guidance regarding the requirements and procedures for thermal inactivation of key pathogenic bacteria and viruses in the context of childcare centres. The risk assessment focus largely, but not exclusively, on well characterized infections associated with high disease burdens (estimated as disability-adjusted life years, DALYs) [15]; and aims to identify key hazardous pathogenic bacteria and viruses that limits the effectiveness of present heat inactivation.

Based on hazard characterization and existing knowledge regarding resistance to inactivation of bacteria and viruses, it was determined that the key viral and bacterial target microorganisms important within the context of dry heat inactivation using heating cabinets were Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), human Norovirus (NoV) and Vancomycin Resistant Enterococci (VRE). In brief, SARS-CoV-2 because of the severity of the Coronavirus disease 2019 (COVID-19), the emergence of multiple new variants of SARS-CoV-2 and the many scientific and experimental uncertainties associated with transmission, pathogenicity and stability of the different SARS-CoV-2 variants; human Norovirus because of it being a documented common cause of outbreaks at childcare centres; and VRE because of the limited availability of therapeutic options (i.e. antibiotics) and the well characterised heat resistance of Enterococci (VRE includes both *Enterococcus. faecalis and E. faecium).* Further these different types of pathogens have been found to have sufficient stability in the environment and importantly also low minimum infective doses.

For intended and normal use of the drying cabinet, with a plateau temperature of above 55 ˚C in the drying cabinet (Easy Dryer 1900) manufactured by Nimoverken AB, and a representative time of more than 100 min, it could be summarized into the conclusions that

more than a sufficient inactivation equal to a minimum 9 log reduction ($TCID_{50}$) is achieved for SARS-CoV-2 and that for Noroviruses a substantial and most likely sufficient inactivation occurs. In contrast, for VRE no significant inactivation occurs.

# 6 Discussion and conclusion

In general microbiological literature, when the microbiologist do not have access to relevant temperature measurements of the process in the equipment, nor the needed magnitude of the required microbial inactivation of infectious viruses, it is common to present the time needed to inactivate a specific number of log reduction at a fix specific temperature. For SARS-CoV-2 it is common to present a time like 5 min at 70 ˚C, with data taken from the experiments reported by Chin et al. [32]. However from there number it is not clear that a 5 log reduction (standard value for all organisms in hospitals) is relevant for the microorganism in the specific situation, nor that a temperature of 56 ˚C is optimal, but just give the experimental temperature.

It is the authors of this report's opinion that for Ninoverken ABs situation these general (however correct) numbers above should be meet by a discussion that:

i) Also include other microorganisms than SARS-CoV-2 in the discussion as the SARS-CoV-2 is easier to inactivate then most of the other relevant known viruses that might cous problems in childcare centres environment.
ii) Argue for the need of a different and sometimes higher inactivation target in the kindergarten environment should be used, based on the differences in risk for different microorganisms. Use numbers from Figure 12 below.
iii) Avoid comparing times connected with temperatures more than 5 ˚C away from the relevant situation. Use numbers from Figure 12 below.
iv) Acknowledge that data and predictions are uncertain: as the situation in childcare centres environment are far from the idealized experimental conditions in the laboratory models and that lot of data is still missing.

| Temperature [˚C] | Murine Norovirus-wrc | SARS-CoV-2 (Wet) | *E. faecium* ($a_w$ 65%) |
|---|---|---|---|
| Sufficient order of inactivation | 9 log | 9 log | 5 log |
| 45 | Almost no inactivation | 5 h | No inactivation |
| 50 | 8 h | 100 min | No inactivation |
| 55 | 130 min | 30 min | No inactivation |
| 60 | 40 min | 15 min | Almost no inactivation |
| 65 | 12 min | 5 min | 6 h |
| 70 | 4 min | 2 min | 2 h |

Figure 12 Sufficient inactivation targets and time needed for inactivation recommended to choose from when communicating according to i)-iv) above.

In cases where even more compact communication is needed the following phrasing is suggested:

For intended and normal use of the drying cabinet, it could be summarized into the conclusions that more than a sufficient inactivation is achieved for SARS-CoV-2. For the Noroviruses a substantial and most likely sufficient inactivation occurs, and for VRE an insignificant inactivation occurs.