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The Effect of Bubble Bottle Humidifiers on Absolute Humidity When Using Low Flowrates in Neonates in Critical Care Settings: A Bench Study

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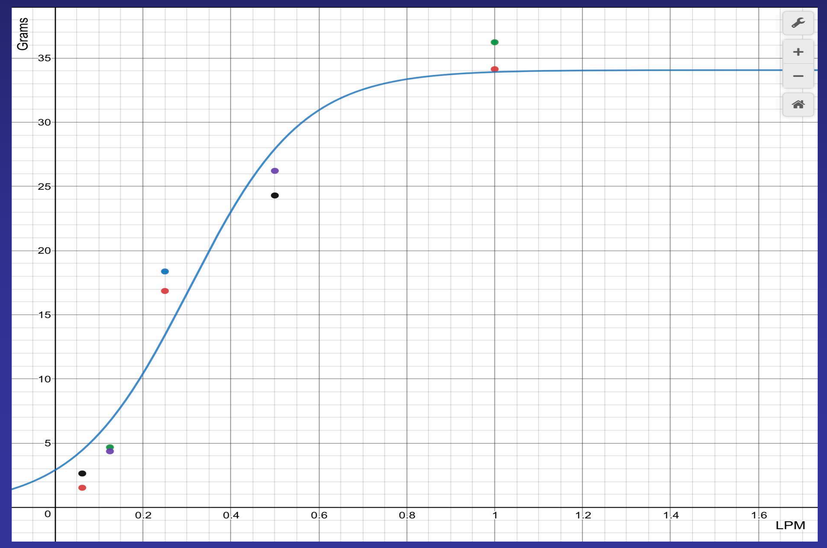
Introduction: Humidification for the neonate is a critical part of quality care. However, there is a lack of research on the effectiveness of non-heated, nasal cannula bubble bottle humidifiers at flowrates less than 2 LPM. The purpose of this study was to identify whether or not bubble bottle humidifiers are an effective form of humidification at extremely low flowrates in the neonatal population. This bench study evaluated the amount of absolute humidity potentially delivered to the neonate at five commonly-used low flowrates in the neonatal patient population. The following are the intended oxygen flowrates, in LPM, for this study: 1/16, ⅛, ¼, ½, and 1.0. Lastly, this study will evaluate the cost efficacy of using bubble bottle humidifiers in this population at the flowrates listed above.

Methods and Materials: Bubble bottle humidifier (Hudson RCI prefilled humidifier AuqaPak); cannula (Saltzer lab rf #1601-7): an inline hygrometer (CEM DT-321) to assess the humidity at the distal end of the cannula. The following flowrates were selected: 1/16, ⅛, ¼, ½, and 1.0 LPM. Each flowrate ran continuously for 24 hours with a humidifier inline. Before each test was run, the temperature and relative humidity were measured with the hygrometer and recorded at the following locations: 1) ambient, 2) at the distal end of the cannula prior to the humidifier being connected, and 3) at the distal end of the cannula after the humidifier was connected. After the humidifier ran for 24 hours, the ambient relative humidity and temperature were recorded at each location; the absolute humidity was calculated from the results using the calculation AH=Mv/V. The humidifiers were weighed before and after each test with an A&D EJ-610 scale; results were recorded to determine the total amount of water displaced from the bottle over 24-hours. Each trial was repeated twice, at each flowrate.

Grams of water displaced over 24 hours



	bubble bottle 1 test 1	bubble bottle 1 test 2	bubble bottle 2 test 1	bubble bottle 2a test 2	bubble bottle 3 test 1	bubble bottle 3a test 2	bubble bottle 4 test 1	bubble bottle 4a test 2	bubble bottle 5 test 1	bubble bottle 5a test 2
	1 l/m	1 l/m	1/2 l/m	1/2 l/m	1/4 l/m	1/4 l/m	1/8 l/m (.12)	1/8 l/m	1/16 l/m (.06)	1/16 l/m
Weight Pre (g)	396.71 g	400.80 g	407.28 g	390.46 g	406.28 g	389.74 g	407.27 g	409.28 g	394.24 g	392.66 g
Weight Post (g)	362.57 g	364.56 g	381.06 g	366.16 g	389.42 g	371.36g	402.59 g	404.91 g	391.6 g	391.13 g
Change in Weight	34.14 g	36.24 g	26.22 g	24.3 g	16.86 g	18.38 g	4.68 g	4.37 g	2.64 g	1.53 g
Difference in AH	0.002 kg/m3	0.001 kg/m3	0.000 kg/m3	0.000 kg/m3	-0.001 kg/m3	0.000 kg/m3	0.007 kg/m3	0.000 kg/m3	0.001 kg/m3	0.000 kg/m3

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Results: There was minimal change in absolute humidity prior to the connection of the humidifier and after the connection to the humidifier. Because one milliliter of water weighs one gram, we can infer that weight loss from the bottle correlates with water delivered through the cannula to the patient. As the flowrate decreased, the weight loss from the humidifier bottle also decreased, representing a lower amount of absolute humidity delivered to the patient over 24 hours.

Conclusions: Insensible water can vary widely in infants and neonates, but is estimated to average between 15 to 170 ml/kg/day.[1] Based on the results of this study, there is minimal increase in absolute humidity delivered to the neonate at the very low flowrates relative to expected insensible water loss. On average a case of 12 bubble bottles with their adaptors costs $27.00. The cost associated with running a humidifier is likely unnecessary, due to the lack of absolute humidity delivered to the neonate.

References

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