Randomized double-blind trial of the effects of humidified compared with nonhumidified low flow oxygen therapy on the symptoms of patients

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OBJECTIVE: To determine the effects of humidified versus nonhumidified low flow oxygen therapy on the subjective symptoms of patients.

METHODS: Randomized double-blind clinical trial conducted in a tertiary care university teaching hospital. The sample included medical and surgical in-patients receiving oxygen therapy who met criteria including medical stability, no overt cognitive impairment, English comprehension, voluntary participation and attending physician agreement. Humidified subjects numbered 96 and nonhumidified subjects were 95. The intervention was humidified or nonhumidified oxygen administration using two flowmeters covered by an opaque bag. Patients receiving oxygen therapy longer than three days (first period) were crossed to the alternate treatment (second period) and followed for three more days.

RESULTS: Mean symptom scores for nasal dryness were low (mild) for both groups; however, humidification group scores were significantly lower (P=0.018) in the first period than the nonhumidification scores. A corresponding increase in the incidence of nosebleeds was not statistically significant between groups nor were there statistically significant differences between groups for other symptoms/problems. The prevailing trend was decreased incidence of dry mouth, dry throat, headache and chest discomfort during the study.

CONCLUSIONS: Although this sample was large enough to expose statistically significant group differences in nasal dryness, the difference was not judged to be clinically significant. The predominant trend was a decrease in symptom scores over time with either treatment. In this group of patients, humidified oxygen does not appear to alleviate subjective symptoms.

Key Words: Humidification, Oxygen, Patient symptoms

Essai randomisé à double insu comparant les effets d’une oxygénothérapie à faible débit et humidifiée avec les effets d’une oxygénothérapie non humidifiée sur les symptômes des patients

OBJECTIF : Déterminer les effets d’une oxygénothérapie à faible débit et humidifiée par rapport à une oxygénothérapie à

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Humidified versus nonhumidified low flow oxygen

The purpose of this study was to determine the clinical effects of humidified versus nonhumidified low flow oxygen administration on the subjective symptoms of patients.

PATIENTS AND METHODS

A randomized double-blind experimental study design was used. The independent variable was the method of low flow oxygen administration. The treatment group received humidified oxygen whereas the control group received nonhumidified oxygen according to standard hospital practice. Dependent variables included symptoms of dry nose, dry mouth, dry throat, headache, chest discomfort and other possible problems (nosebleed, cough, phlegm).

Sample: Potential subjects were patients admitted to one tertiary care university teaching hospital who were prescribed low flow oxygen therapy by nasal prongs or mask. Selection criterion was the predicted administration of supplemental oxygen therapy of 4 L/min or less for each patient for two or more days. Subjects were to be included if they were medically stable, lacked evidence of cognitive impairment, were able to give informed consent, comprehended English and their attending physician agreed with their participation. When oxygen therapy was ordered, potential subjects who met inclusion criteria were provided with verbal and written explanations about the purpose of the study and extent of participation before their informed voluntary consent was requested. Randomization of each subject to group was based on computer generated tables. The study was approved by the hospital and university research and ethics committees.

Procedure: Only the respiratory therapistcommencing the oxygen administration knew of the patient’s random assignment to group. Patients received oxygen using two flowmeters attached to a duplex outlet. Only one flowmeter was attached to a humidification bottle so that randomization to either treatment was possible. The entire apparatus was covered by an opaque bag to blind patients and caregivers to the method of oxygen administration. Patients who received oxygen therapy for longer than three days (first period) were crossed over
TABLE 1
Demographic characteristics

| Variable                  | Nonhumidification Number (%) | Humidification Number (%) |
|--------------------------|------------------------------|---------------------------|
| Sex                      |                              |                           |
| Female                   | 57 (45)                      | 53 (48)                   |
| Male                     | 69 (54)                      | 58 (52)                   |
| Prior home oxygen        | 17 (13)                      | 21 (19)                   |
| Remained in study        |                              |                           |
| Day 0 (baseline)*        | 126 (100)                    | 111 (100)                 |
| 1                        | 95 (75)                      | 96 (86)                   |
| 2                        | 70 (56)                      | 74 (67)                   |
| 3†                      | 52 (41)                      | 54 (49)                   |
| 4                        | 36 (29)                      | 40 (36)                   |
| 5                        | 28 (22)                      | 33 (30)                   |
| 6                        | 21 (17)                      | 24 (22)                   |

†Despite inclusion criteria requiring medical stability and that oxygen therapy be anticipated to last for two or more days, patient attrition (n=93) occurred from baseline (day 0) to day 2 for the following reasons: oxygen therapy discontinued (n=55); patient discharged (n=16); patient withdrew (n=11); medical instability (n=5); changes in patient location (n=4); medical instability (n=2) †Further patient attrition (n=99) occurred from day 2 to day 6 because oxygen therapy was discontinued (n=56); patient was discharged (n=31); patient withdrew (n=5); medical instability (n=2); or changes in patient location (n=5)

RESULTS

Subjects: In total 1576 nonintubated patients ordered to receive low flow supplemental oxygen were evaluated for study. Of these, 1182 did not meet inclusion criteria; 237 of the remaining 394 eligible patients became voluntary sub-
jects after receiving information about the study. There were 157 patient refusals, with reasons stated as follows: not interested (n=63); unwell (n=40); preferred humidity (n=37); unable to comprehend concept (n=6); and miscellaneous (n=11). Most of the patients who refused had respiratory (n=77), gastrointestinal (n=30) or circulatory (n=24) disorders. The final sample included 150 medical and 87 surgical patients from seven patient care units. Data were gathered over 10 months including autumn, winter and spring.

Characteristics between groups were compared for age, sex and administration of home oxygen before hospital admission (Table 1). Mean age was 61.9 years and 62.7 years for the nonhumidification and humidification groups, respectively. No significant differences in demographic characteristics were found between groups.

Of the 16 patients who withdrew, six stated a sense of increased dryness as the reason. Four others were unwell (“too tired”, etc), two became confused, two were “not interested”, one preferred dry oxygen and one had miscellaneous reasons.

Symptom and problem scores: The primary symptom of interest was nasal dryness. Mean symptom scores for nasal dryness (Figure 1) indicate a statistically significant decrease (P=0.018) in dryness symptoms in the humidification group relative to the nonhumidification group in the first period. This difference is characterized by a slight, insignificant increase in symptoms in the nonhumidified group compared with a significant decrease (P=0.002) in the humidified arm from baseline to day 1. The same pattern difference did not occur in the second period after treatment crossover, as evidenced by a statistically significant period-treatment interaction (P=0.043) (Figure 1).

A second measure of interest was nosebleed. Results (Figure 2) indicate a corresponding increase in the incidence of nosebleeds in the nonhumidified compared with the humidified groups, peaking at day 2, which did not, however, attain statistical significance (P=0.093).
There were no statistically significant differences between treatments for the four other symptoms. The prevailing trend in both groups was towards decreased incidence of dry mouth and dry throat, and in headache and chest discomfort over the study (Table 2). In particular, mouth dryness (P=0.01), headache (P<0.0001) and chest discomfort (P=0.0001) showed marked decreases from baseline to the first day. Thereafter, the general trends over the study were downward and statistically significant, except for the symptom of headache.

**DISCUSSION**

Based on a pilot project, it was anticipated that a larger number of subjects would receive oxygen therapy for at least three days. However, oxygen therapy for a shorter time period (ie, 24 h or less) and decreasing lengths of stay resulted in higher attrition rates, particularly noticeable with surgical patients. Campbell et al (1) also observed comparatively short term oxygen administration for subjects in their study and reported that only 17 of 185 patients received supplemental nasal oxygen of 5 L/min for four days or more. Short term humidified oxygen therapy for acute care patients is a frequent occurrence that has important cost implications, given the amount of funding currently allocated by medium and large hospitals to purchase humidification bottles for oxygen administration. For the study hospital of approximately 500 beds, this amounted to more than $40,000 per year.

All symptoms except dry nose improved over time whether oxygen therapy was humidified or not. Because subject effects were accounted for in the analysis, these patterns can not be attributed to progressive attrition in symptom-prone patients during the study. Patients’ most frequent complaints at the level of “some” or greater discomfort were relative to dry mouth, cough and phlegm. Humidification did not appear to have an obvious clinical advantage in alleviating these symptoms.

The original suspicion that a lack of humidity might affect patient comfort by increasing the occurrence of dry nose was supported by the statistically significant difference between groups for dry nose. However, because the mean scores between groups representing patients’ perceptions of their symptom severity were in the mild range, this difference is not clinically relevant.

The lack of clinical relevance for the severity of dry nose with nonhumidified oxygen and the improvement reported by patients over three days with other symptoms/problems whether oxygen therapy was humidified or not suggests guidelines for clinicians. We recommend nonhumidification for short term low flow oxygen therapy (ie, up to three days). However, when oxygen therapy is ordered, patients should be assessed individually for their propensity for dry nose and nosebleed and, based on this assessment, clinicians may elect to order humidified oxygen for individual patients.

Findings from this study do not support continuation of routine humidification with low flow oxygen therapy on the basis of improved patient comfort and presumed improvement in their subjective symptoms because most symptoms/problems were not alleviated by oxygen humidification. Some may argue that further research is needed to address other possible effects achieved with humidified oxygen administration before established therapies are jettisoned. For example, investigations have been suggested to determine the effect of humidified oxygen on the rate of recovery for patients with chest disease (5), on its effect on asthmatics and on its relationship to patient outcomes (eg, length of stay and infection rates). Others would question the need for additional evidence to continue a therapy with unproven benefit. We recognize that further studies would allow comparison of the effects of humidified and nonhumidified oxygen therapy on the symptoms of patients in similar diagnostic categories according to severity of illness. Although replication of this study with a larger sample would confirm or refute present study findings, larger studies are difficult to justify based on anticipated cost savings. Consequently, we recommend that patient outcomes be monitored with routine short term nonhumidified oxygen therapy, especially for possible adverse occurrences such as dry nose and nosebleed. Findings from this study contribute new informa-

| TABLE 2 | Incidence (per patient day) of symptoms (symptom score = 2) or problems (presence of nosebleed, cough, phlegm) in first period* |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Nonhumidified Day 0† | Days 1-3 | Humidified Day 0 | Days 1-3 |
| Day 0† | Days 1-3 | Day 0† | Days 1-3 |
| Dry nose (%) | 41.5 | 40.9 | 40.9 | 29.1 |
| Dry mouth (%) | 60.6 | 53.0 | 63.4 | 50.2 |
| Dry throat (%) | 48.9 | 42.8 | 38.7 | 36.2 |
| Headache (%) | 19.1 | 11.7 | 26.9 | 16.4 |
| Chest discomfort (%) | 44.7 | 22.9 | 34.4 | 23.6 |
| Nosebleed (%) | 10.6 | 17.3 | 10.8 | 10.8 |
| Cough (%) | 76.6 | 80.4 | 86.0 | 78.4 |
| Phlegm (%) | 59.6 | 56.3 | 69.9 | 63.8 |

*Scores for dry nose, dry mouth, dry throat, headache and chest discomfort: 0 = no discomfort; 1 = mild discomfort; 2 = some discomfort; 3 = moderate discomfort; 4 = severe discomfort. Scale for nosebleed, cough, phlegm: yes or no. †Day 0 is baseline day.
tion compared with previously published studies of less rigorous design. The sample size of the present study was sufficient to achieve statistical significance and is larger than that of other studies focused on oxygen humidification reported in the literature. The large number of subjects who did not meet inclusion criteria and who were discontinued after enrolment was unfortunate, yet reflects current patterns of delivering oxygen therapy in hospital.

Changing hospital policy to accept nonhumidification as the standard method for delivering low flow oxygen therapy has potential benefits, including the possibility of decreasing the patient’s risks of developing nosocomial pneumonia, reducing expenditures for oxygen therapy and eliminating one source of biomedical waste. The findings and recommendations make a significant contribution at a critical time in the evolution of evidence-based care and a focus on patient outcomes.

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REFERENCES
1. Campbell E, Baker M, Crites-Silver P. Subjective effects of humidification of oxygen for delivery by nasal cannula. A prospective study. Chest 1988;93:289-93.
2. Cahill C, Heath J. Sterile water used for humidification in low-flow oxygen therapy: Is it necessary? Am J Infect Cont 1990;18:13-7.
3. Henderson E, Ledgerwood D, Myrthu Hope K, et al. Prolonged and multipatient use of prefilled disposable oxygen humidifier bottles: Safety and cost. Infect Control Hosp Epidemiol 1992;14:463-8.
4. Estey W. Subjective effects of dry versus humidified low flow oxygen. Respir Care 1980;25:1143-4.
5. Conway J. The effects of humidification for patients with chronic airways disease. Physiotherapy 1992;78:97-101.
6. Laird N, Ware J. Random-effects models for longitudinal data. Biometrics 1982;38:963-74.
7. Zeger S, Liang K-Y. Longitudinal data analysis for discrete and continuous outcomes. Biometrics 1986;42:121-30.

BOOKS
Comprehensive human physiology: From cellular mechanisms to integration, volumes 1 and 2. Rainer Gregor, Uwe Windhorst (1996). Springer-Verlag New York Inc, 333 Meadowlands Parkway, Secaucus, New Jersey USA 07094. 2528 pages; ISBN 3-54058109-X; US$129.00.

The editors have assembled 106 experts in their respective fields of physiology to write a textbook to provide not only basic concepts but also the most recent developments in physiology. The basic aim was not to provide yet another introductory text, but to compile current knowledge for a more advanced readership.

The test is divided into two volumes: one devoted primarily to cellular physiology and aspects of neuroscience and the second to the organ systems and reproduction. With this format, the text uses the concept that the integrative physiological processes can be understood best from the basis of cellular and molecular biology, biochemistry and biophysics.

All the chapters are well illustrated with both figures and tables. They all have excellent up-to-date reference lists, making it convenient for a reader to gather further information on specific topics.

Although the editors have directed the text to a more advanced readership, the text appears to be more a reference book for those wishing to review specific areas of interest. Because of the amount of information provided (two large volumes, 126 chapters), the text is not very well suited to graduate or medical students. In addition, the specialty chapters are not the level of review articles such as those that are published in peer-reviewed journals. This work would be excellent for those who have been away from the field and need to review it at a more advanced level than appears in basic texts.

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