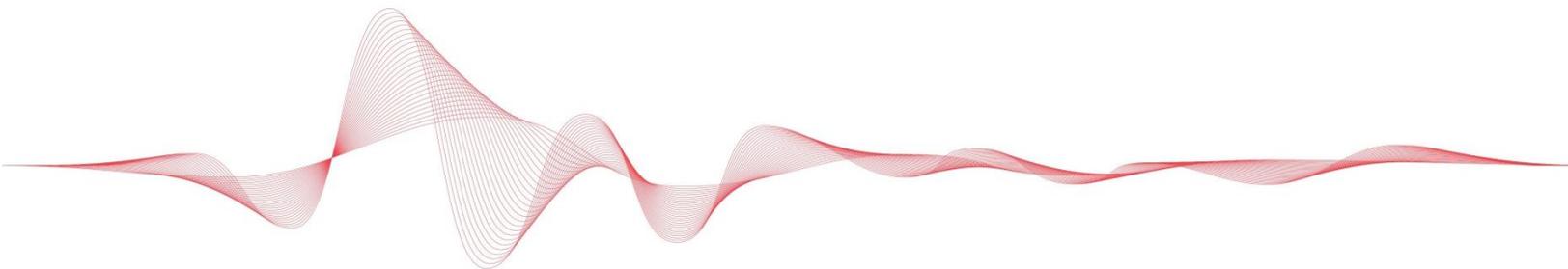


Importance of Compliance in HME Use

- ❖ Tracheal climate
- ❖ Clinical effects
- ❖ Cost-effectiveness



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Preface

This document contains a bibliography and summaries of selected publications relating to the importance of compliance in HME use. The document is part of a growing, and regularly updated collection of documents, the *Atos Medical Clinical Evidence Series*, covering various clinical topics related to Atos Medical's areas of expertise. The topics are chosen based on questions that we receive from our customers.

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Tracheal climate

The lack of conditioning effects of the nose and breathing resistance after total laryngectomy may result in reduced pulmonary rehabilitation due to reduced cilia functions. By using HME, the inspiratory temperature and moisture increase resulting in an improved endotracheal climate¹. When comparing HMEs with different resistance, the high resistant HME resulted in increased moisture and tidal volume in the patients². The short-term effect in HME use was seen to increase end-inspiratory, end-expiratory temperature and humidity when compared to non-HME use^{3,7}. This suggests that HME use has a relatively fast efficacy onset on the endotracheal climate. When comparing inter- and intra-patient variability, the intra-patient variability on HME performance was reported higher suggesting the positioning of HME to be important factor⁴. Hence, for best possible HME performance – focus should be given on optimally sealing the adhesive to the stoma.

In cold climate, the use of HME resulted in significant increase in inspiratory, expiratory temperature and moisture⁵. The effect on the intra-airways was seen to be maintained by HME use⁶. In summary, these findings suggest that HME use has important short-term on the tracheal climate and that it is effective in different climate zones.

The publications listed below concern the publications regarding tracheal climate that are referenced above. Clicking the link while holding the Ctrl key will take you directly to the summary you are interested in.

¹[Scheenstra et al. Heat and moisture exchange capacity of the upper respiratory tract and the effect of tracheotomy breathing on endotracheal climate. Head Neck 2011 Jan;33\(1\):117-24](#)

²[Scheenstra et al. Influence of breathing resistance of heat and moisture exchangers on tracheal climate and breathing pattern in laryngectomized individuals. Head Neck 2010 Aug;32\(8\):1069-78](#)

³[Scheenstra et al. Short-term endotracheal climate changes and clinical effects of a heat and moisture exchanger with an integrated electrostatic virus and bacterial filter developed for laryngectomized individuals. Acta Otolaryngol. 2010 Jun;130\(6\):739-46](#)

⁴[Scheenstra et al. Endotracheal temperature and humidity measurements in laryngectomized patients: intra- and inter-patient variability. Med.Biol.Eng Comput. 2009 Jul;47\(7\):773-82](#)

⁵[Zuur et al. The influence of a heat and moisture exchanger on tracheal climate in a cold environment. Med.Eng Phys. 2009 Sept;31\(7\):852-57](#)

⁶[Zuur et al. Assessment of tracheal temperature and humidity in laryngectomized individuals and the influence of a heat and moisture exchanger on tracheal climate. Head Neck 2008 Aug;30\(8\):1072-82](#)

⁷[Keck et al. Tracheal climate in laryngectomees after use of a heat and moisture exchanger. Laryngoscope. 2005 Mar;115\(3\):534-7.](#)

Scheenstra et al., 2011

Title

Heat and moisture exchange capacity of the upper respiratory tract and the effect of tracheotomy breathing on endotracheal climate.

Authors

Scheenstra RJ, Muller SH, Vincent A, Hilgers FJ.

Affiliation(s)

Department of Head and Neck Oncology and Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Journal and year of publication

Head Neck. 2011 Jan;33(1):117-24.

Type of publication

Prospective study

Introduction

The aim of this study was to assess the heat and moisture exchange (HME) capacity of the upper respiratory tract and the effect of tracheotomy breathing on endotracheal climate in patients with head and neck cancer.

Subjects and Methods

This was a prospective study where they plotted the subglottic temperature and humidity measurements in 10 patients with head and neck cancer with a temporary precautionary tracheotomy during successive 10-minute periods of nose, mouth, and tracheotomy breathing in a randomized sequence.

Results

End-inspiratory temperatures of nose, mouth, and tracheotomy breathing were 31.1, 31.3, and 28.3 degrees C, respectively. End-inspiratory humidity measurements of nose, mouth, and tracheotomy breathing were 29.3, 28.6, and 21.1 mgHO/L, respectively. There was a trend toward lower end-inspiratory humidity in patients with radiotherapy or with large surgery-induced oropharyngeal mucosal defects, whereas temperatures were similar.

Conclusion

This study gives objective information about the HME capacity of the upper respiratory tract in patients with head and neck cancer with precautionary tracheotomy, and thus provides target values for HMEs for laryngectomized and tracheotomized patients.

Scheenstra et al., 2010

Title

Influence of breathing resistance of heat and moisture exchangers on tracheal climate and breathing pattern in laryngectomized individuals.

Authors

Scheenstra RJ, Muller SH, Vincent A, Sinaasappel M, Hilgers FJ.

Affiliation(s)

Department of Head and Neck Oncology and Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Journal and year of publication

Head Neck. 2010 Aug;32(8):1069-78.

Type of publication

Prospective study

Introduction

The aim of this study was to determine the influence of breathing resistance of heat and moisture exchangers (HMEs) on endotracheal climate and breathing pattern.

Subjects and Methods

Six patients were identified; 4 underwent total laryngopharyngectomy, and 2 underwent total laryngectomy. Endotracheal temperature and humidity and tidal volumes were measured in 11 laryngectomized patients with a regularly used HME with "standard" breathing resistance (Provox Normal HME; R-HME), a low breathing-resistance HME (Provox HiFlow HME; L-HME), and without HME.

Results

Both R-HME and L-HME increased end-inspiratory humidity (+5.8 and 4.7 mgH₂O/L, respectively), decreased end-inspiratory temperature (-1.6 and -1.0 degrees C, respectively), and prolonged the exhalation breath length to approximately 0.5 seconds. The R-HME significantly enlarged tidal volumes (0.07 L; p < .05).

Conclusion

Both HMEs significantly improve tracheal climate. The R-HME has better moistening properties and a small but significant positive effect on tidal volume. Therefore, if the higher resistance is tolerated, the R-HME is the preferred pulmonary rehabilitation device. The L-HME is indicated if lower breathing resistance is required.

Scheenstra et al., 2010

Title

Short-term endotracheal climate changes and clinical effects of a heat and moisture exchanger with an integrated electrostatic virus and bacterial filter developed for laryngectomized individuals.

Authors

Scheenstra RJ, Muller SH, Vincent A, Ackerstaf AH, Jacobi I, Hilgers FJ.

Affiliation(s)

Department of Head and Neck Oncology and Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Journal and year of publication

Acta Otolaryngol. 2010 Jun;130(6):739-46.

Type of publication

Prospective study

Introduction

Recently an HME with an integrated antimicrobial filter has become available for use in laryngectomized patients. The purpose of this study was to assess its short-term endotracheal climate changes and feasibility in daily practice.

Subjects and Methods

Endotracheal temperature and humidity were successfully measured in 13 laryngectomized patients (2652 analysed full breaths), during 10 min rest-breathing with the R-HME, with an F-HME and without HME in a randomized sequence. Additionally, a 3 week prospective clinical feasibility trial was conducted in 17 laryngectomized patients.

Results

Both R-HME and F-HME increase endotracheal minimum humidity values (5.8 and 4.7 mgH₂O/L, respectively; $p < 0.0001$). Compared with open stoma breathing, in contrast to the R-HME, the F-HME increases both end-inspiratory and end-expiratory temperature values (1.1 degrees C, and 0.6 degrees C, respectively). After the 3-week clinical feasibility trial, one patient dropped out; 11 patients (11/16 = 69%) disliked the larger design of the F-HME and all patients reported less optimal airtight occlusion. Five patients (5/16 = 31%) reported remarkably decreased sputum production.

Conclusion

Both the regularly used heat and moisture exchanger (R-HME) and the HME with both an antimicrobial and hygroscopic element (F-HME) are effective moisture exchangers.

Scheenstra et al., 2009

Title

Endotracheal temperature and humidity measurements in laryngectomized patients: intra- and inter-patient variability.

Authors

Scheenstra RJ, Muller SH, Vincent A, Sinaasappel M, Zuur JK, Hilgers FJ.

Affiliation(s)

Department of Head and Neck Oncology and Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Journal and year of publication

Med Biol Eng Comput. 2009 Jul;47(7):773-82.

Type of publication

Prospective study

Introduction

This study aimed at assessing the intra- vs inter-patient variability in endotracheal climate when using HME.

Subject and Methods

This was a prospective study that assesses intra- and inter-patient variability in endotracheal climate (temperature and humidity) and effects of heat and moisture exchangers (HME) in 16 laryngectomized individuals, measured repeatedly (N = 47). Inhalation Breath Length (IBL) was 1.35 s without HME and 1.05 s with HME (P < 0.0001).

Results

This study assesses intra- and inter-patient variability in endotracheal climate (temperature and humidity) and effects of heat and moisture exchangers (HME) in 16 laryngectomized individuals, measured repeatedly (N = 47). Inhalation Breath Length (IBL) was 1.35 s without HME and 1.05 s with HME (P < 0.0001)..

Conclusion

(1) Because inter-patient variability is smaller than intra-patient variability, investigating endotracheal climate in a limited number of laryngectomized subjects is justified, provided repeated measurements per patient are accomplished; (2) main contributor to intra-patient variability is the positioning of the catheter tip in the trachea; (3) an HME leads to a shortened IBL which enhances the HME effect.

[Link to open access article](#)

Zuur et al., 2009

Title

The influence of a heat and moisture exchanger on tracheal climate in a cold environment.

Authors

Zuur JK, Muller SH, Vincent A, Sinaasappel M, de Jongh FH, Hilgers FJ.

Affiliation(s)

Department of Head and Neck Oncology and Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Journal and year of publication

Med Eng Phys. 2009 Sep;31(7):852-7.

Type of publication

Prospective study

Introduction

The incidence of pulmonary complaints, severe tracheitis and lung function deterioration is increased during wintertime in laryngectomized individuals. We analyzed how a heat and moisture exchanger (HME) performs in cold and dry ambient circumstances, and how its efficiency in this environmental climate might be improved.

Subjects and Methods

This was a randomized crossover study. Intra-tracheal temperature and humidity were measured in 10 laryngectomized patients with and without HME, in a cold (mean, 4.7 degrees C) and dry room (mean, 4.5 mg H₂O/L).

Results

Presence of an HME causes the intra-tracheal mean humidity minima and maxima to increase with 4.2 mgH₂O/L (95%CI: 3.3-5.0 mg H₂O/L; p<0.001) and 2.4 mg H₂O/L (95%CI: 1.7-3.1 mg H₂O/L; p<0.001), respectively. The intra-tracheal mean temperature minima and maxima increased with 3.9 degrees C (95%CI: 2.7-5.1 degrees C; p<0.001) and 1.2 degrees C (95%CI: 0.8-1.2 degrees C; p<0.001), respectively. In the majority of patients, the calculated relative humidity values appear to reach well above 100% during inspiration.

Conclusion

In a cold environment, presence of an HME significantly increases both inspiratory and expiratory temperature and humidity values. Relative humidity calculations suggest the formation of condense droplets during inspiration. To further increase its effectiveness, improvement of the HME's thermal capacity should be aimed for.

Zuur et al., 2008

Title

Assessment of tracheal temperature and humidity in laryngectomized individuals and the influence of a heat and moisture exchanger on tracheal climate.

Authors

Zuur JK, Muller SH, Vincent A, Sinaasappel M, de Jongh FH, Hilgers FJ.

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Department of Head and Neck Oncology and Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Journal and year of publication

Head Neck. 2008 Aug;30(8):1072-82.

Type of publication

Prospective study

Introduction

The beneficial function of heat and moisture exchangers (HMEs) is undisputed, but knowledge of their effects on intra-airway temperature and humidity is scarce. The aim of this study was to evaluate the clinical applicability of a new airway climate explorer (ACE) and to assess the HME's influence on tracheal climate.

Subjects and Methods

Intratracheal temperature and humidity were measured with and without HME in 10 laryngectomized patients.

Results

An HME causes the intratracheal mean humidity minima to increase with 3.2 mg H₂O/L (95% CI: 1.5-4.8 mg H₂O/L; p <.001), from 21.4 to 24.6 mg H₂O/L, and the mean temperature minima to decrease with 1.6 degrees C (95% CI: 0.9-2.4 degrees C; p <.001) from 28.5 degrees C to 26.9 degrees C. Relative humidity values suggest that the tested HME keeps inspired air (nearly) fully saturated during the full course of inspiration.

Conclusion

Assessment of intratracheal temperature and humidity, and evaluation of HME effectiveness is feasible with the ACE. The tested HME significantly increases the intratracheal humidity, but decreases the intratracheal temperature. Relative humidity calculations suggest that increasing the thermal capacity of this rehabilitation device can further increase the heat and moisture exchange efficiency.

Keck et al., 2005

Title

Tracheal climate in laryngectomees after use of a heat and moisture exchanger.

Authors

Keck T, Dürr J, Leiacker R, Rettinger G, Rozsasi A.

Affiliation(s)

ENT Department, University of Ulm, Ulm, Germany.

Journal and year of publication

Laryngoscope. 2005 Mar;115(3):534-7.

Type of publication

Prospective study

Introduction

Heat and moisture exchangers (HME) are frequently used in the treatment and prevention of tracheobronchial dryness and infections. In this study, the short-term influence of the HME Prim-Air System (Heimomed, Kerpen, Germany) in laryngectomized patients was tested.

Subjects and Methods

After adaptation to the laboratory environment, tracheal humidity and temperature were measured before HME application, 1 minute after HME application, 10 minutes after HME application, 1 minute after removal of the HME, and 10 minutes after removal of the HME.

Results

When the HME was placed on the tracheal stoma, the end-inspiratory humidity and temperature increased significantly. Ten minutes after commencement of use of the HME, tracheal humidity further increased significantly. Ten minutes after removal of the HME, tracheal humidity and temperature decreased to values as before start of use of HME.

Conclusion

The results indicate that short-term use of the HME Prim-Air system rapidly changes the tracheal climate. The significant increase in tracheal temperature and humidity may have beneficial effects on tracheal dryness in laryngectomized patients.

Clinical Effects

HME use has been seen to improve well-being and pulmonary health in laryngectomees and that long-term compliance further improves the results¹⁰⁻¹¹. Main reasons for non-compliant use are mucus production and skin irritation⁷. By using HME at night further improves pulmonary functions and reducing mucus production compared to day time use only⁹. The improved effect on pulmonary functions was seen after 2-weeks HME use, with an improved QoL was reported confirming its short-term effects². This may be explained by restored and functional tracheal ciliated cells that may further result in a reduced number of tracheobronchitis and pneumonia rounds for HME-users^{1,4}. As these findings may result in reduced hospital admissions, compliant HME-use could be cost-beneficial compared to usual care^{3,8}. The performances of HME types varies with Provox XtraMoist and XtraFlow to be one of the top performing HMEs on the market^{5,6}.

The publications listed below concern the publications regarding clinical effects that are referenced above. Clicking the link while holding the Ctrl key will take you directly to the summary you are interested in.

[1van den Boer C, Muller SH, van der Noort V, Olmos RA, Minni A, Parrilla C, Hilgers FJ, van den Brekel MW, van der Baan S. Effects of heat and moisture exchangers on tracheal mucociliary clearance in laryngectomized patients: a multi-center case-control study. Eur Arch Otorhinolaryngol. 2015 Nov;272\(11\):3439-50.](#)

[2Parrilla C, Minni A, Bogaardt H, Macri GF, Battista M, Roukos R, Pandolfini M, Ruoppolo G, Paludetti G, D'Alatri L, de Vincentiis M. Pulmonary Rehabilitation After Total Laryngectomy: A Multicenter Time-Series Clinical Trial Evaluating the Provox XtraHME in HME-Naïve Patients. Ann Otol Rhinol Laryngol. 2015 Sep;124\(9\):706-13.](#)

[3Retèl VP, van den Boer C, Steuten LM, Okła S, Hilgers FJ, van den Brekel MW. Cost-effectiveness of heat and moisture exchangers compared to usual care for pulmonary rehabilitation after total laryngectomy in Poland. Eur Arch Otorhinolaryngol. 2015 Sep;272\(9\):2381-8.](#)

[4van den Boer C, van Harten MC, Hilgers FJ, van den Brekel MW, Retèl VP. Incidence of severe tracheobronchitis and pneumonia in laryngectomized patients: a retrospective clinical study and a European-wide survey among head and neck surgeons. Eur Arch Otorhinolaryngol. 2014 Dec;271\(12\):3297-303.](#)

[5van den Boer C, Muller SH, Vincent AD, van den Brekel MW, Hilgers FJ. Ex vivo assessment and validation of water exchange performance of 23 heat and moisture exchangers for laryngectomized patients. Respir Care. 2014 Aug;59\(8\):1161-71.](#)

[6Herranz J, Espiño MA, Morado CO. Pulmonary rehabilitation after total laryngectomy: a randomized cross-over clinical trial comparing two different heat and moisture exchangers \(HMEs\). Eur Arch Otorhinolaryngol. 2013 Sep;270\(9\):2479-84.](#)

[7Pedemonte-Sarrías G, Villatoro-Sologaistoa JC, Ale-Inostroza P, López-Vilas M, León-Vintró X, Quer-Agustí M. \[Chronic adherence to heat and moisture exchanger use in laryngectomized patients.\] Acta Otorrinolaringol Esp. 2013 Jul-Aug;64\(4\):247-52.](#)

⁸[Brook I, Bogaardt H, van As-Brooks C. Long-term use of heat and moisture exchangers among laryngectomees: medical, social, and psychological patterns. Ann Otol Rhinol Laryngol. 2013 Jun;122\(6\):358-63.](#)

⁹[Bien et al. The effect of a Heat and Moisture Exchanger \(Provox HME\) on pulmonary protection after total laryngectomy: a randomized controlled study. Eur Arch Otorhinolaryngol. 2010 Mar;267\(3\):429-35.](#)

¹⁰[Ackerstaff et al. Long-term compliance of laryngectomized patients with a specialized pulmonary rehabilitation device: Provox Stomafilter. Laryngoscope. 1998 Feb;108\(2\):257-60.](#)

¹¹[Ackerstaff et al. Heat and moisture exchangers as a treatment option in the post-operative rehabilitation of laryngectomized patients. Clin Otolaryngol Allied Sci. 1995 Dec;20\(6\):504-9.](#)

Van den Boer et al, 2015

Title

Effects of heat and moisture exchangers on tracheal mucociliary clearance in laryngectomized patients: a multi-center case-control study.

Authors

van den Boer C^{1,2}, Muller SH³, van der Noort V⁴, Olmos RA⁵, Minni A⁶, Parrilla C⁷, Hilgers FJ^{8,9}, van den Brekel MW^{10,11,12}, van der Baan S¹³.

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¹³Department of Otorhinolaryngology, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands.

Journal and year of publication

Eur Arch Otorhinolaryngol. 2015 Nov;272(11):3439-50.

Type of publication

Prospective study.

Introduction

After total laryngectomy, inspired air is no longer optimally conditioned by the upper airways. Impaired mucociliary clearance and histological changes of respiratory epithelium, such as loss of ciliated cells, have been described in laryngectomized patients. Heat and moisture exchangers (HMEs) are passive humidifiers that re-condition the inspired air.

Subjects and Methods

Aim of this study was to assess the effect of HMEs on tracheal epithelium and tracheal mucus transport velocity (TMV). Tracheal brush biopsies were collected in three groups of TLE patients: 21 long-term HME users, 10 non-HME users, and 16 non-HME users before and after 4-9 months HME use. Tracheal epithelium biopsies were assessed using a digital high-speed camera mounted onto a light microscope. TMV was determined by scintigraphy in the first two patient groups.

Results

Significantly more ciliated cells were found in HME users compared to non-HME users ($p = 0.05$). TMV was higher in HME users (median 2 mm/min; 0-7.9) compared to non-HME users (median 0.8 mm/min; 0-12.3), but this difference was not significant ($p = 0.37$). One-hour breathing without HME in long-term HME users did not measurably decrease TMV ($p = 0.13$).

Conclusion

The long-term use of an HME restores/prevents the loss of tracheal ciliated cells. A significant improvement in TMV was not found. Short-term (one hour) detachment of an HME has no measurable effect on TMV.

Parrilla et al, 2015

Title

Pulmonary Rehabilitation After Total Laryngectomy: A Multicenter Time-Series Clinical Trial Evaluating the Provox XtraHME in HME-Naïve Patients.

Authors

Parrilla C¹, Minni A², Bogaardt H³, Macri GF², Battista M¹, Roukos R², Pandolfini M¹, Ruoppolo G², Paludetti G¹, D'Alatri L¹, de Vincentiis M².

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Journal and year of publication

Ann Otol Rhinol Laryngol. 2015 Sep;124(9):706-13.

Type of publication

Prospective study.

Introduction

Both the immediate beneficial physiological changes in a laboratory setting and the long-term clinical outcomes of heat and moisture exchanger (HME) use are well described. So far, there has not been any research published that provides detailed insight in the pattern of changes in both respiratory function and patients' experiences with HMEs in the first weeks of use.

Subjects and Methods

A multicenter time-series study design with a 2-week double baseline period. All patients used the XtraHME for 12 weeks afterward. Data were collected 2 weeks, 6 weeks, and 12 weeks after the start of HME use.

Results

Data of 30 patients were analyzed. Pulmonary symptoms decreased significantly during the 12 weeks of HME use. After 2 weeks, a significant decrease in daily coughs and daily forced expectorations was seen. The general quality of life showed a significant increase throughout the study. More general physical complaints also significantly decreased with HME use. Patient satisfaction with the HME was high.

Conclusion

This study shows that there is a significant influence of the XtraHME on pulmonary status that can already be observed after 2 weeks of using the XtraHME and continues to improve further after 6 weeks of XtraHME use.

Retèl et al, 2015

Title

Cost-effectiveness of heat and moisture exchangers compared to usual care for pulmonary rehabilitation after total laryngectomy in Poland.

Authors

Retèl VP¹, van den Boer C, Steuten LM, Okta S, Hilgers FJ, van den Brekel MW.

Affiliation(s)

¹Department of Psychosocial Research and Epidemiology, Netherlands Cancer Institute-Antoni van Leeuwenhoek (NKI-AVL), Plesmanlaan 121, 1066 CX, Amsterdam, The Netherlands

Journal and year of publication

Eur Arch Otorhinolaryngol. 2015 Sep;272(9):2381-8.

Introduction

The beneficial physical and psychosocial effects of heat and moisture exchangers (HMEs) for pulmonary rehabilitation of laryngectomy patients are well evidenced. However, cost-effectiveness in terms of costs per additional quality-adjusted life years (QALYs) has not yet been investigated. Therefore, a model-based cost-effectiveness analysis of using HMEs versus usual care (UC) (including stoma covers, suction system and/or external humidifier) for patients after laryngectomy was performed.

Subjects and Methods

Primary outcomes were costs, QALYs and incremental cost-effectiveness ratio (ICER). Secondary outcomes were pulmonary infections, and sleeping problems. The analysis was performed from a health care perspective of Poland, using a time horizon of 10 years and cycle length of 1 year. Transition probabilities were derived from various sources, amongst others a Polish randomized clinical trial. Quality of life data was derived from an Italian study on similar patients. Data on frequencies and mortality-related tracheobronchitis and/or pneumonia were derived from a Europe-wide survey amongst head and neck cancer experts.

Results

Substantial differences in quality-adjusted survival between the use of HMEs (3.63 QALYs) versus UC (2.95 QALYs) were observed. Total health care costs/patient were 39,553 PLN (9465 Euro) for the HME strategy and 4889 PLN (1168 Euro) for the UC strategy. HME use resulted in fewer pulmonary infections, and less sleeping problems.

Conclusion

We could conclude that given the Polish threshold of 99,000 PLN/QALY, using HMEs is cost-effective compared to UC, resulting in 51,326 PLN/QALY (12,264 Euro/QALY) gained for patients after total laryngectomy. For the hospital period alone (2 weeks), HMEs were cost-saving: less costly and more effective.

Van den Boer et al, 2014

Title

Incidence of severe tracheobronchitis and pneumonia in laryngectomized patients: a retrospective clinical study and a European-wide survey among head and neck surgeons.

Authors

van den Boer C¹, van Harten MC, Hilgers FJ, van den Brekel MW, Retèl VP.

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Journal and year of publication

Eur Arch Otorhinolaryngol. 2014 Dec;271(12):3297-303.

Type of publication

Retrospective study.

Introduction

Laryngectomized patients, lacking conditioning of the breathing air in the upper respiratory tract, have reported considerable pulmonary complaints. It is assumed that these patients also run a higher risk of developing severe respiratory infections. Unfortunately, there is little scientific information available about the occurrence of respiratory infections and related health costs in these patients with and without the use of an HME. Therefore, the occurrence of respiratory infections in laryngectomized patients was investigated in the Netherlands Cancer Institute and by means of a survey among head and neck oncology surgeons throughout Europe.

Subjects and Methods

The number of tracheobronchitis and/or pneumonia events was retrospectively scored between 1973 and 2013 in medical records of 89 laryngectomized patients treated in our institute. To assess expert experiences and opinions regarding these pulmonary problems, a study-specific survey was developed. The survey was sent by email to head and neck surgeons from ten different countries.

Results

In the medical record study, an average of 0.129 respiratory infections per patient/year was found in non-HME users and 0.092 in HME users. In the survey (response rate HN surgeons 20 %; countries 90 %) 0.285 episodes per patient/year in non-HME users was statistically higher than the 0.066 episodes per patient/year in HME users. The average mortality in the HME user group per entire career of each physician was estimated at 0.0045, and for the non-HME user group this was 0.0152.

Conclusion

There is a tendency that the number of tracheobronchitis and pneumonia episodes in non-HME users is higher than in HME users.

Van den Boer et al, 2014

Title

Ex vivo assessment and validation of water exchange performance of 23 heat and moisture exchangers for laryngectomized patients.

Authors

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Journal and year of publication

Respir Care. 2014 Aug;59(8):1161-71.

Introduction

Breathing through a tracheostoma results in insufficient warming and humidification of the inspired air. This loss of air conditioning, especially humidification, can be partially restored with the application of a heat and moisture exchanger (HME) over the tracheostoma. For medical professionals, it is not easy to judge differences in water exchange performance of various HMEs owing to the lack of universal outcome measures. This study has three aims: assessment of the water exchange performance of commercially available HMEs for laryngectomized patients, validation of these results with absolute humidity outcomes, and assessment of the role of hygroscopic salt present in some of the tested HMEs.

Subjects and Methods

Measurements of weight and absolute humidity at end inspiration and end expiration at different breathing volumes of a healthy volunteer were performed using a microbalance and humidity sensor. Twenty-three HMEs from 6 different manufacturers were tested. Associations were determined between core weight, weight change, breathing volume, and absolute humidity, using both linear and nonlinear mixed effects models.

Results

Water exchange of the 23 HMEs at a breathing volume of 0.5 L varies between 0.5 and 3.6 mg. Both water exchange and wet core weight correlate strongly with the end-inspiratory absolute humidity values ($r^2 = 0.89/0.87$). Hygroscopic salt increases core weight.

Conclusion

The 23 tested HMEs for laryngectomized patients show wide variation in water exchange performance. Water exchange correlates well with the end-inspiratory absolute humidity outcome, which validates the ex vivo weight change method. Wet core weight is a predictor of HME performance. Hygroscopic salt increases the weight of the core material. The results of this study can help medical professionals to obtain a more founded opinion about the performance of available HMEs for pulmonary rehabilitation in laryngectomized patients, and allow them to make an informed decision about which HME type to use.

[Link to open access article](#)

Herranz et al, 2013

Title

Pulmonary rehabilitation after total laryngectomy: a randomized cross-over clinical trial comparing two different heat and moisture exchangers (HMEs).

Authors

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Journal and year of publication

Eur Arch Otorhinolaryngol. 2013 Sep;270(9):2479-84.

Type of publication

Prospective study.

Introduction

Post-laryngectomy heat and moisture exchanger (HME) use is known to have a beneficial effect on tracheal climate, pulmonary symptoms and related aspects. This study aims to investigate differences in clinical effects between the first and second generation Provox HMEs. The second generation (Provox XtraHME) has better humidification properties than the first generation (Provox HME), and has been shown to further improve tracheal climate.

Subjects and Methods

Forty-five laryngectomized patients, who were already using an HME, participated in a prospective, randomized cross-over clinical study in which each HME was used for 6 weeks.

Results

Results showed that for most parameters studied, the second generation HME performed equally well or better than the first generation HME. The improvement in tracheal climate translated into patients reporting significantly less tracheal dryness with the second generation than with the first generation ($p = 0.039$).

Conclusion

Using an HME with better humidification properties is related to a reduction in tracheal dryness in our study population with the second generation HME to perform equally well or better than its predecessor.

Pedemonte-Sarrias et al., 2013

Title

Chronic adherence to heat and moisture exchanger use in laryngectomized patients.

Authors

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Journal and year of publication

Acta Otorrinolaringol Esp. 2013 Jul-Aug;64(4):247-52.

Type of publication

Prospective study

Introduction

Total laryngectomy leads to pulmonary problems such as excessive sputum production, forced expectoration and increased coughing. The use of a heat and moisture reduces these symptoms. The aim of this study was to quantify chronic adherence to HME use in laryngectomized patients

Subjects and Methods

115 patients were questioned about the use of HMEs.

Results

Of the 115 patients, 90 (78.2%) used the HME consistently and 25 (21.8%) abandoned its use. The most common causes of desertion were adhesion problems due to mucus and skin irritation. Of the 30 patients with voice prostheses, 90% of them used the HME system regularly. Voice prosthesis use ($P=.05$) and early indication in postoperative laryngectomy ($p=.001$) were factors significantly associated with chronic HME use.

Conclusion

There is high adherence (78.2%) to heat and moisture exchanger (Provox HME) use in laryngectomized patients. Chronic HME use was higher in patients with voice prosthesis and the ones with early indication in postoperative period. The major causes of abandonment were related to problems with the adhesive.

Brook et al, 2013

Title

Long-term use of heat and moisture exchangers among laryngectomees: medical, social, and psychological patterns.

Authors

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Journal and year of publication

Ann Otol Rhinol Laryngol. 2013 Jun;122(6):358-63.

Introduction

After laryngectomy, pulmonary protection is mostly acquired by means of a heat and moisture exchanger (HME) that is placed on an airtight seal around the stoma. The effects of HMEs on the tracheal climate have been well described, and the filtration effect of an HME with an electrostatic filter has been described in vitro. The effects of HME use in patients have been documented in several trials in different countries. The follow-up time of the patients in these trials, however, is limited. Less is known about long-term use of HMEs, and studies describing long-term compliance with HME use are scarce. This study investigated the long-term use of HMEs in laryngectomees.

Subjects and Methods

Questionnaires were sent to 195 laryngectomees, and 75 questionnaires were returned.

Results

More than 85% of the respondents used an HME, of whom 77% were compliant users (ie, use for more than 20 hours per day). The incidence of pulmonary illnesses (either before or after surgery) was about 25%. More than 90% of the respondents were heavy smokers before laryngectomy. One third of the respondents are regularly exposed to dusty environments. Compliant HME users tend to make less use of external humidifiers and vaporizers, and have better pulmonary status and lower health-care costs. Regarding quality of life, patients who use a FreeHands device tended to have more frequent social contacts ($r = 0.251$; $p = 0.030$). The prevalence of depression is high, pointing to an urgent need to recognize and treat psychiatric problems such as depression and suicidal ideation in this patient group.

Conclusion

These findings have implications for any postlaryngectomy research that uses pulmonary parameters.

Bien et al., 2010

Title

The effect of a Heat and Moisture Exchanger (Provox HME) on pulmonary protection after total laryngectomy: a randomized controlled study.

Authors

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Journal and year of publication

Eur Arch Otorhinolaryngol. 2010 Mar;267(3):429-35.

Type of publication

Prospective study

Introduction

The goal of this randomized controlled study was to investigate the effect of Heat and Moisture Exchanger use on pulmonary symptoms and quality of life aspects in laryngectomized patients.

Subjects and Methods

Eighty laryngectomized patients were included and randomized into an HME and Control group. The effect of the HME was evaluated by means of Tally Sheets and Structured Questionnaires.

Results

The results showed a significant decrease in the frequency of coughing, forced expectoration, and stoma cleaning in the HME group. There were trends for the prosthetic speakers to report more fluent speech with the HME and for the HME group to report fewer sleeping problems.

Conclusion

This study, performed in Poland, confirms the results of previous studies performed in other countries, showing that pulmonary symptoms decrease significantly with HME use and that related aspects such as speech and sleeping tend to improve, regardless of country or climate.

[Link to open access article](#)

Ackerstaff et al., 1998

Title

Long-term compliance of laryngectomized patients with a specialized pulmonary rehabilitation device: Provox Stomafilter.

Authors

Ackerstaff AH, Hilgers FJ, Balm AJ, Tan IB.

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Journal and year of publication

Laryngoscope. 1998 Feb;108(2):257-60.

Type of publication

Prospective study

Introduction

Previous studies have demonstrated the positive effect of a heat and moisture exchanger (HME) on the respiratory system in patients after laryngectomy. However, patient compliance with these devices was reduced by device-related problems and troublesome combination with a voice prosthesis. Recently a more specialized device has become available. This is an HME combined with a valve for easy digital occlusion of the stoma (Provox Stomafilter; Hörby, Sweden). In the authors' initial study of this revised device, a clear improvement in short-term compliance was demonstrated.

Subjects and Methods

To investigate long-term compliance, 69 consecutive patients were interviewed by means of a structured questionnaire.

Results

The results show that all patients expressed their satisfaction with the valve used for digital occlusion of the stoma. Sixty-three percent of the patients reported that voicing was facilitated. Subjective intelligibility improved in 55% of the patients. Previous problems with other devices (e.g., plaster adherence, skin irritation, and handling) were clearly diminished, increasing the long-term compliance of the patients to 78%.

Conclusion

This new HME can be considered as a beneficial pulmonary rehabilitation tool for laryngectomized patients.

Ackerstaff et al., 1995

Title

Heat and moisture exchangers as a treatment option in the post-operative rehabilitation of laryngectomized patients.

Authors

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Journal and year of publication

Clin Otolaryngol Allied Sci. 1995 Dec;20(6):504-9.

Type of publication

Prospective study

Introduction

A multi-institutional, prospective clinical study was undertaken to investigate whether the use of a heat and moisture exchanger (HME) in the period following total laryngectomy could prevent the development or reduce the severity of respiratory symptoms.

Subjects and Methods

Fifty-nine patients from three hospitals were provided with HMEs, either immediately post-surgery or, in the case of post-surgical radiotherapy, upon completion of the radiotherapy.

Results

For the total sample (n = 59) statistically significant improvements over time (between 3 and 6 months) could be found in forced expectoration (P < 0.05), in the perceived voice quality (P < 0.001), social anxiety (P < 0.001), social interactions (P < 0.001) and in feelings of anxiety and depression (P < 0.05). Repeated measures analysis of variance indicated statistically significant group differences over time in forced expectoration and stoma cleaning (P < 0.05).

Conclusion

No statistically significant differences over time were noted between the regular and non(regular) HME user groups in voice quality or in various aspects of daily living.