Psychosocial Determinants of Successful Voice Rehabilitation After Laryngectomy

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This study gives an overview of publications on factors that are associated with the outcome of voice rehabilitation after laryngectomy. A systematic literature review was conducted. Fifty-six manuscripts were analyzed regarding the parameters investigated, the number of participants included, the study designs used, the assessment instruments, and the results. A broad range of factors were considered to contribute to successful voice rehabilitation, whereby psychosocial attributes related to success are mentioned as often as medical and treatment-related characteristics. The results of the studies are mostly inconsistent. It can be concluded, however, that active communication behavior, employment status, type of alaryngeal speech and the general physical condition are associated with rehabilitation outcomes, whereas alcohol consumption is not. More comprehensive prospective studies are needed which analyze the impact of psychosocial factors with validated and standardized instruments. A large sample size would be necessary to calculate all possibly relevant factors and their interaction. Clinicians should be careful about considering their patients to be "unmotivated" if the rehabilitation fails; instead, they should encourage them to communicate actively and take part in social activities. [*J Chin Med Assoc* 2007;70(10):407–423]

Key Words: cancer, head and neck neoplasms, laryngectomy, psychosocial factors, speech intelligibility

Introduction

A very important quality-of-life issue after laryngectomy is gaining a new voice. Many clinicians have the impression that psychosocial and sociodemographic factors, such as motivation, mood, age, intelligence, etc., play an important role in this process. This study gives an overview about current investigations concerning the factors which are associated with the outcome of voice rehabilitation.

Methods

An extensive literature review was conducted. PubMed and Scopus were searched using the following key words in all possible combinations: "laryng*", "cancer", "success", "rehabilitation", "speech intelligibility", "voice", "quality of life", and "outcome". The abstracts were scrutinized regarding their suitability for the purpose. All papers, whether empirical studies, reviews, clinical reports, or case studies, were included if their topic was in conjunction with success of voice rehabilitation in laryngectomees. Papers written in the following languages were considered: English, German, Dutch, Russian, Croatian/Serbian/Bosnian, Polish, French, and Spanish.

The papers were read carefully, and the articles they referred to were reviewed again. In doing so, an extensive literature search was made. The included papers were analyzed regarding the investigated parameters, the number of included patients, the study design, the assessment instruments used and the results.

For reasons of comparability, all studies were summarized. Each investigated parameter got a column in the table. The results of every study that investigated this parameter were symbolized as follows: a plus (+) means that a positive association was found, a minus (−) stands for negative associations and a zero (0) for no significant association. When the cell is empty, it

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means that the particular factor was not investigated by these authors.

Results of the association between a potential factor on the one hand and successful voice rehabilitation on the other hand had different levels of consistency. We considered an association as *consistent* when all studies that were conducted on this topic had the same results. A prerequisite for this is of course that at least 2 studies were published concerning this particular association. We considered results as *uncertain* when not all but most of the analyzed studies came to the same conclusion or if only 1 study investigated this association. *Inconsistent* results do not show a clear picture of associations, which means that nearly half of the studies found opposite relations.

Results

A total of 56 papers from 16 countries were included. Table 1,[1–39] Table 2[16,18,40–42] and Table 3[43–48] contain all of them together with a short description of the study design and the results. Twenty-three of the manuscripts were original papers.

Criteria of success

First of all, it has to be stated that there is no overall accepted criterion for success in gaining a new voice after laryngectomy. Some authors define the voice rehabilitation as successful when the patients can *speak in any manner*.[49] Particularly in older publications, sometimes the attainment of the esophageal voice is considered to be a success.[6,25,39] The application of voice rehabilitation methods differ remarkably, namely in international terms and even in terms of a single country. Since the 1980s, rehabilitation with tracheoesophageal puncture has been conducted more frequently. In some countries, however, in Japan for example, this form of voice rehabilitation is, to date, still relatively rare.[22] Five to 15% of all patients cannot acquire a suitable substitute voice (Table 4).[1,5,6,12,13,21,22,26,31–35,38,39,44,50] If the person concerned cannot read or write, it turns out to be especially problematic.

Other authors require that one must speak *socially acceptably*.[22] This can mean that the patient is able to speak at least words and not only syllables,[25,51] or that he can handle specific situations where communication is required, e.g. talking on the phone.[35]

Other criteria for successful rehabilitation are the *intelligibility of language*,[52,53] the *sound*, the *pitch*[54] and the *speed*[42] of the voice—each can be measured in an objective manner[55]—as well as the *patient's contentment*[56] with that. It has been shown that subjective and objective assessments of speech intelligibility are poorly associated.[12,17,34,57]

Another focus of interest is whether the new voice is *used in daily life*.[26] About 15% of all prosthesis speakers never or very seldom use the prosthesis.[23] During the rehabilitation process, some patients give up their primary voice rehabilitation and change to another. For instance, in 1 study, the voice prosthesis was used more often immediately after the laryngectomy, whereas 5 years thereafter, esophageal voice and electronic devices were used more frequently.[26] About 10% of the patients with voice prostheses wanted their device to be removed.[20] In a Spanish study,[58] even 70% asked for removal of the prosthesis, although all patients found that the prosthesis voice sounded better than the esophageal voice. It can be assumed that in some cultures, for instance in Southern Europe, people are used to talking with many gestures. Therefore, the hands are needed for communication. When using specific kinds of voice prostheses or electronic devices, only 1 hand is free for speaking and people can feel restricted in communication. The fistula must in part be closed also for medical reasons. The incidence of shunts that had to be closed, due to the patient's wish or for medical necessities, was between 30% and 70%.[9,13,26,58,59]

A criterion of success could also be the *preferences of the audience*. Only 2 studies have considered this factor.[43,60] In a study that was conducted to determine speech quality in different voice prostheses, it was shown that less educated listeners found speech quality better in those prostheses that did not need a finger to close them.[60] The authors presume that this could be put down to the sound of the valves. The acceptance of alaryngeal speech thus depends on the education level of the listener and on the visibility of the handicap.

In another study,[43] young adults and children were asked to assess tape recorded voices. These voices were either esophageal, electrolaryngeal or prosthetic (Staffieri prostheses). The listeners were asked to point out which habits in their opinion the speaker would have. Both groups of listeners attributed negative habits to esophageal and prosthetic voices. The electrolaryngeal voice, however, was assessed as neutral by the adolescents and positive by the children. One explanation for this could be the fact that children are used to hearing such voices in animated movies they watch.

Factors associated with success

Twenty-four of the papers reviewed dealt with the association between successful voice restoration and potential factors of influence. The following 25 parameters were investigated in these studies: age, social status,

Table 1. Original papers

Sample	*n*	Access to the patients (Country, City)	Study design	Methods and instruments	Results	Reference
LE	63	Ambulance of the National Cancer Institute (The Netherlands, Amsterdam)	Cross-sectional	Structured interview	Subjectively experienced quality of voice correlated with fatigue, frequency of telephone calls, and anxiety to speak. No difference between esophageal and prosthesis speakers.	1
LE	152	Rehabilitation clinic (GDR, Gelenau)	Prospective	Freiburg Speech Intelligibility Test and audiogram	Acquisition of a useful voice was not correlated with hearing ability. Quality of esophageal voice was weakly correlated with hearing ability.	2
LE	275	Rehabilitation clinic (GDR, Gelenau)	Prospective	Freiburg Speech Intelligibility Test	Causes of failure were: esophageal stenoses 23%, infiltrates at the neck 18%, too little speech therapy 23%, psychologic factors 17%, older age 8%, general physical condition 8%, aversion to burp 3%, hearing disability 1%.	3
LE	253	Rehabilitation clinic (GDR, Gelenau)	Prospective	Assessment by therapist	Use of an artificial larynx did not affect the acquisition of an esophageal voice.	4
LE	63	No information (USA)	Cross-sectional	PAIS-SR MHLoC Self-questionnaire	Internal locus of control correlated with good adjustment and fewer communication problems.	5
LE	335	Association of laryngectomees (Western Germany)	Cross-sectional	Self-questionnaire	28% did not speak; 59% used esophageal voice.	6
LaCa	20	Oncological clinic (Ireland, Dublin)	Matched pairs	Hamilton Rating Scale for Depression Beck Depression Inventory	Depression correlated with poor quality of voice.	7
LE with TEP	36	ENT clinic (USA)	Cross-sectional	Functional communication profile	2/3 of patients had good quality of speech. Failure was correlated with: weak sight, reduced mobility, radiation therapy. Failure was not correlated with: alcohol consumption, hearing disability, tumor site, tumor stage, primary or secondary TEP.	8

(*Contd*)

Table 1. Continued

Sample	*n*	Access to the patients (Country, City)	Study design	Methods and instruments	Results	Reference
LE	20	ENT clinic (Greece, Thessaloniki)	Retrospective	Volume in dB Duration of phonation Counting	Volume: prosthesis better than esophageal voice Duration: prosthesis better than esophageal voice Counting: prosthesis better than esophageal voice 60% of the prostheses remained, 40% were removed.	9
ENTCa	110	Clinic (The Netherlands, Rotterdam)	Cross-sectional	Coping-Questionnaire of van den Borne Cancer Locus of Control Ryckman's physical self-efficacy scale Rotterdam-SCL	Patients indicated good quality of speech – following radiotherapy: 68% – following LE: 26% – following LE and neck dissection: 69%	10
LE	35	ENT clinics (Germany, Würzburg & Tübingen)	RCT t1: following stay in hospital t2: 6 mo later	PLTT Questionnaire of psychosocial adjustment after LE	Withdrawal from conversations correlated with poor quality of speech.	11
LE	105	ENT clinic (Germany, Bremen)	Cross-sectional	Self-questionnaire	Speech was intelligible: – 6 wk following LE: in 16% of the patients who used esophageal speech, 45% of the patients with electronic device and 71% with TEP. – 6 mo following LE: in 78% of the patients who used esophageal speech, 80% of the patients with electronic device and 100% with TEP. – subjective: in 92% of the patients who used esophageal speech, 78% of the patients with electronic device and 89% with TEP. Communication via phone was more difficult for TEP-speakers.	12
LE with TEP	350	ENT clinic (Spain, Valencia)	Cross-sectional	No information given	70% had good quality of speech. 16% could not acquire any speech (6% failure, 10% lack of motivation or sociocultural reasons).	13

LE	116	No information (people living in Arkansas, Texas, Oklahoma, & Louisiana)	Cross-sectional	Self-questionnaire Recorded telephone calls Wepman's 7-point Speech Proficiency Scale Counting until 100	Speech quality was correlated with: radiation therapy, education, socioeconomic status, time interval since LE, amount of speech therapy. Speech quality was not correlated with: employment, extension of the operation, age.	14
LE	240	International Association of Laryngectomees (USA)	Retrospective	Self-questionnaire	Speech quality was better if patients kept in touch with friends.	15
LE	20	Self help group (USA, Dallas)	Cross-sectional	Observation of communication behavior FIRO-B List of words Self-questionnaire	Speech quality was high if: – partner encouraged to long answers – there were differences in opinion – partners paid attention to the other's needs	16
LE	20	ENT clinic (UK, Sheffield)	Prospective (according to routine aftercare visits)	Assessment by – Surgeon – Speech therapist – Layman – Patient	Patients gave the worst assessments, speech therapists the best. Age only had influence on surgeons' assessment (greater age correlated with good speech quality).	17
LaCa	332	Veterans Administration Hospitals (USA)	RCT *Arm A:* CT + RT + eventually LE *Arm B:* LE + RT	Tape recordings – Forming vocals – Reading text – Describing picture – Reading random words Logemann-Questionnaire	Speech quality A > B (problem: 50% of B-patients had artificial larynxes, therefore the data were biased). Speech quality: TEP > esophageal speakers. Active communication behavior: esophageal > TEP-speakers. B: t4 very similar to t6, meaning no relevant changes after 1 yr.	18
LE	49	Mayo Clinic (USA, Minnesota)	Prospective t1: 6–10 d following LE t2: 3 mo following LE	Wechsler Adult Intelligence Scale Shipley-Hartford Institute of Living Scale MMPI Wepman's 7-point Speech Proficiency Scale	Speech quality at t2 correlated with: speech quality at t1, depression, education level. Speech quality at t2 did not correlate with: age, intelligence, introversion, amount of speech therapy, other psychiatric disorders.	19

(*Contd*)

Table 1. Continued

Sample	*n*	Access to the patients (Country, City)	Study design	Methods and instruments	Results	Reference
LE	43	ENT clinic (Belgium, Leuven)	Cross-sectional	Assessment by therapist	TEP speakers had better speech quality. TEP speakers acquired new voice faster than others. TEP was the most expensive rehabilitation method. 10% of all TEP speakers wished to have their prosthesis removed.	20
LE	138	Rehabilitation clinic for veterans (USA, Portland)	Cross-sectional	Assessment by therapist Self-questionnaire	Acquisition of speech depends on age and motivation (this was a hypothesis of the authors; it was not empirically tested).	21
LE	65	ENT clinic (Japan, Kanagawa)	Cross-sectional	No information given	Acquisition of speech did not depend on age.	22
LE	56	ENT clinic (Switzerland, Bern)	Prospective t1: 2 mo following LE t2: 6 mo following LE t3: 1 yr following LE	HRS-Tracheoesphageal Puncture Rating Scale	Functional speech was possible at t1 *vs.* t2 *vs.* t3: – with primary TEP 26% *vs.* 43% *vs.* 56% of patients – with secondary TEP 20% *vs.* 40% *vs.* 25% of patients 15% of all TEP speakers used their voice scarcely or never. Speech quality of TEP speakers could be enhanced by good cleaning of the prosthesis.	23
LE with TEP	95	ENT clinic (Finland, Helsinki)	Cross-sectional	Assessment by ENT doctor, laryngologist & speech therapist	Risk of failure was correlated with: poor general health, somatic comorbidity, decision for electrolarynx, older age, uncoordinated hand movement.	24
LE	52	ENT clinic (Sweden, Linköping)	Prospective t1: before LE t2: following LE	Esophageal manometry Interview	Significant influence: age No influence: extension of surgery or RT, problems with swallowing, alcohol consumption, smoking, mental health	25
LaCa & hypopharyngeal Ca	173	Radiation clinic (USA, Florida, Gainesville)	Cross-sectional	Analysis of medical records Assessment by therapist	Electrolarynx was rehabilitation method most used. About 50% of TEP operation patients used prosthesis on long-term basis, 21% had complications. Reasons for use of prosthesis (= success): – dose of RT, OR 2.3 – place of surgery (center or not), OR 1.9 All other medical factors were not significant.	26

					Use of rehabilitation methods seen on long-term basis (≥ 2 yr *vs.* ≥ 5 yr): – prosthesis: 27% *vs.* 19% – electrolarynx: 50% *vs.* 57% – esophageal speech: 1% *vs.* 3% – no speech: 17% *vs.* 14%	
LE	189	Association of laryngectomees, tumor registries, ENT doctors, speech therapists (Norway)	Cross-sectional	Semistructured interview Self-questionnaire	Risk of failure was correlated with: age, swallowing problems, small tracheostoma, dependency on canulla, personality, premorbid adjustment.	27
Advanced LaCa	29	ENT clinic (Germany, Göttingen)	Cross-sectional	Self-questionnaire PLTT Multidimensional voice program	Speech intelligibility did not correlate with: age, amount of speech therapy.	28
LE	41	ENT clinic (Spain, Valencia)	Prospective, but only cross-sectional data published	PAIS-SR	78% of all TEP speakers acquired good speech quality.	29
LE	60	ENT clinics, ENT doctors, self help groups (USA)	Cross-sectional	In-depth interview Analysis of medical records SIP CES-D	Speech quality correlated with: support by family & friends (minor correlation), support by other LEs & health care providers (strong correlation). Speech quality did not correlate with: socioeconomic status, extension of surgery, marital status.	30
LE	73	ENT clinic, self-help group (Germany, Hamburg)	Cross-sectional	Self-questionnaire	There were no differences in acquiring speech between esophageal & electrolaryngeal speakers. Use of electrolarynx did not affect acquisition of esophageal voice.	31
LE	85	ENT clinic (USA, New York)	Cross-sectional	Assessment by therapist	Quality of esophageal speech: excellent 7%, good 29%, fair 9%, poor 10%. No influence: neck dissection. Influence: age, cognitive fitness, hearing problems, edema, motivation, living alone, emotional problems (problem: some of these factors were not evaluated in the study empirically).	32

(*Contd*)

Table 1. Continued

Sample	*n*	Access to the patients (Country, City)	Study design	Methods and instruments	Results	Reference
LE	7,008	Rehabilitation clinic (Germany, Bad Reichenhall)	Cross-sectional	PLTT or assessment by therapist	Best speech quality acquired with TEP (80%). Success of voice rehabilitation decreased when inpatient rehabilitation was too short & too quick following LE.	33
LE	40	ENT clinic (Germany, Jena)	Cross-sectional	PLTT Self-questionnaire	Subjective & objective assessments matched only in 35% of cases.	34
LE	108	Association of laryngectomees (Taiwan)	Cross-sectional	Self-questionnaire	Intelligibility did not correlate with type of voice (TEP, esophageal, electrolaryngeal, pneumatic).	35
LE	150	Association of laryngectomees (Belgium)	Cross-sectional	Self-questionnaire	Younger patients learned more quickly. Fast beginning of voice rehabilitation did not help.	36
LE	59	ENT clinic, phoniatry (USA, New York)	Cross-sectional	Analysis of medical records Assessment by therapists	Risk factors for failure of voice rehabilitation: no employment, poor income planning, social dependencies, postoperative complications (e.g. infections), mobility of the tongue, swallowing problems, irregular therapies. No correlation with: alcohol consumption, smoking, mental health, education, motivation, family relations, extension of operation, hearing disability. If there were > 3 risk factors for failure, then risk for failure is very high (signal detection theory).	37
LE & PLE	t1: 92 t2: 50	ENT clinic (Australia)	Prospective t1: 1 yr following LE t2: 6 yr following LE	Analysis of medical records Therapy-Outcome-Measure-LE-Scale	Distress: LE < PLE Disability and handicap: LE = PLE EL < TEP in all areas	38
LE	106	ENT clinic (Poland, Poznan)	Cross-sectional	Self-questionnaire	Intelligence correlated positively with good voice. Highly intelligent people initially had more problems in acquiring speech, but were more persevering.	39

GDR = German Democratic Republic; LE = laryngectomees (or laryngectomy depending on context); PLE = pharyngolaryngectomees; TEP = patients with tracheoesophageal puncture; E = esophageal speakers; EL = electrolaryngeal speakers; LaCa = patients with laryngeal cancer; RCT = randomized controlled trial; t1 = first measurement; t2 = second measurement; t3 = third measurement; CT = chemotherapy; RT = radiotherapy.

Table 2. Reviews

Design	Results	Reference
Review	If problems with speech: depression is increased	40
Review	Motivation is important for esophageal speech All other results: the original papers are reviewed in Table 1	41
Comprehensive "state of the art" within original paper	Use of voice methods: writing 5–35%, electrolarynx 5–66%, esophageal speech 12–97% successful (in a prospective study 26%), TEP 30–93% successful Intelligibility of voice methods: electrolarynx 32–90%, esophageal speech 49–96%, TEP 65–93% Correlation with successful rehabilitation: – Esophageal speech: *Positive*: extension of operation, positive attitude, adjustment, frequency of speech therapy, social support *Negative:* lack of motivation, physical weakness, postoperative radiotherapy, dysphagia – Voice prosthesis: *Negative*: medical complications, lack of motivation, lack of hygiene, difficulties in closing the tracheostoma with finger, choking	18
Review	Esophageal speech: 25–95% failure rate (4 studies, 3 from 1982, 1 from 1992) Voice prosthesis: better than esophageal speech, especially in length of phonation (12 s > 2 s, normal voice: 25 s)	42
Comprehensive "state of the art" within original paper	Speech quality does not correlate with anatomic parameters, but with sociodemographic ones (age, sex, socioeconomic status) & psychologic ones (depression, self-esteem, feeling of inferiority, motivation).	16

Table 3. Case histories or expert opinion

Design	Results	Reference
Expert opinion	Adolescents had to assess taped voices of laryngectomees: they considered esophageal speakers and prosthesis speakers as negatively different (malicious, sad, unfriendly), electrolaryngeal speakers as neutral, younger children even as friendly and good. 60% could learn esophageal voice, independently of age. If electrolaryngeal speech is offered too early, motivation to learn the esophageal voice decreases.	43
Overview with some studies	10–15% could not learn any voice, 14–76% learned esophageal voice.	44
Clinical experiences with 72 patients	50% of all esophageal speakers could communicate in public. 12%: removal of the prosthesis necessary.	45
Expert opinion	In the 1970s, there were 3 wrong assumptions: (1) electrolaryngeal speech hinders learning of esophageal speech; (2) everybody can learn esophageal speech; (3) psychosocial factors are the main reasons for failure in gaining a new voice. What really matters in rehabilitation is physiology, not anatomy. Differences in treatment are caused much more by culture than by evidence.	46
Expert opinion	Psychosocial factors of failure: lack of motivation to overcome the illness, too shy to burp, lack of drive. Somatic factors of failure: muscles of the shoulder, lymph edema, hardened tissue, hearing weakness, poor general health, exclusively thoracale breathing.	47
Case history	A female patient whose tongue had been removed reported about her experiences. She tried 3 years to acquire a new voice, without success. In the self-help group, she felt like an outsider because of her failure. She found it difficult to go to a party where one needed to hold a drink, purse, paper and pencil. The question with all the notices was: Where should they stay? Everybody could read it. One time she wanted to help a lady across the street, and this lady got fearful because of her voicelessness.	48

Table 4. Prevalence of voice rehabilitation methods, arranged chronologically*

Country	*N*	Sample	Prosthesis	Esophageal voice	Electrolaryngeal voice	Pneumatic device	Esophageal & electrolaryngeal voice	No voice	Reference
1873 First total laryngectomy by Billroth									
Poland	106	LE	–	66					39
USA	62	LE	–	58	10			35	21
USA	85	LE	–	56	22			21	32
1979 Introduction of Blom-Singer prosthesis									
Germany	335	LE		59				28	6
Germany	73	LE		40	26		25		31
Germany	Different clinics	LE	5.6	69	28			6.7	50
USA	63	LE	30	54	15				5
Netherlands	63	LE	77	14	4			6	1
Germany	105	LE	9	67	36		11	4	12
UK	Review	LE						10–15	44
Germany	130	LE	60						33
Spain	350	TEP	70					16	13
Japan	65	LE	0	6	12		81	9	22
USA	118	LE†	27	1	50			17	26
USA	69	LE‡	19	3	57			14	26
Germany	40	LE	70	30					34
Taiwan	108	LE	6	25	10	60			35
Australia	55	LE	74	8	26			0	38
Australia	37	PLE	30	0	65			5	38

**Data are presented as % unless otherwise indicated (the sum of the percentages is not always 100% because some authors considered patients "without voice" as an extra group and some did not); †2 years after surgery; ‡5 years after surgery. LE = laryngectomees; TEP = patients with tracheoesophageal puncture; PLE = pharyngolaryngectomees.*

marital status, employment, education, social support, personality, intelligence, motivation, psychosocial adjustment, active communication behavior, social activity, mental health (especially depression), alcohol consumption, amount and quality of speech therapy, extension of surgery, tumor stage, tumor site, swallowing problems, mobility of the tongue, type of alaryngeal voice, hearing weakness, radiation therapy, (different) postoperative complications, and general physical condition. Table 5 summarizes the results per parameter.[1–3,5,8,11,13,14,16,18,19,22,24,25,27,30,32,33,36,37,39,40,47,52,61,62] Table 6 gives an overview of the consistency of the data.

The voice prosthesis was superior to all other rehabilitation methods in most of the phoniatric parameters, e.g. pitch, intelligibility, and range.[42] There were also, however, indications that volume and maximum phonation time is equal in prosthesis and esophageal speakers.[55] Sometimes, it was feared that patients who used an artificial larynx would be unmotivated to learn the esophageal voice.[43] It was shown that this was not regularly the case.[4,31,37]

A poor general physical condition was often found to be negatively associated with successful voice rehabilitation (Table 5). The amount of alcohol consumption did not correspond with the rehabilitation outcome. All other physical or treatment-related factors were not consistently associated with the criteria of successful voice rehabilitation.

It seems safe to assume that people who communicate actively and who have employment acquire better voices than others (Tables 5 and 6). Possibly also, depression, poor psychosocial adjustment, and older age are associated with failure to speak. This was, however, not shown consistently. Very inconsistent results have been published concerning the influence of intelligence, socioeconomic status and social support.

We have to state that in all of the analyzed papers, no empirical work was done to find out the association between motivation and rehabilitation outcome in an appropriate manner. Mostly, it was just claimed that failure was due to a lack of motivation. This impression is probably based on clinical experience. In some studies, motivation was evaluated by the therapist, never by the patients themselves, and always after the rehabilitation as a *post hoc* explanation of failure, never before the outcome measurement.

Discussion

Our aim was to find and summarize all factors that are relevant for voice rehabilitation success after laryngectomy. Furthermore, it would be helpful to quantify the results of the studies and compare them. This is, however, only possible when researchers use standardized or at least validated instruments and when a clear, concise criterion for success is defined.

Before one can compare different studies, it is necessary first to define the outcome criterion, and secondly to analyze the process of rehabilitation. If a change in outcome over time is probable, this should be considered in the study designs. The different criteria for successful voice rehabilitation make it difficult to compare the results of the reported studies. Another problem is that most of the investigations were cross-sectional, which does not allow us to analyze the data in terms of causality.

Reviewing all the studies, what draws our attention first is that an enormous number of parameters are considered to contribute to voice rehabilitation outcome. A vast sample size would be necessary to analyze the impact and interaction of all of these parameters. To date, there have only been a few studies that have tried to analyze not only the single factors but also the interactions between them.

All in all, 25 parameters were regarded as possible influencing factors in the reported studies. Given the fact that the appropriate way to calculate them together would be a multivariate analysis, and given the fact that at least 10 datasets per category per parameter are necessary for a reliable calculation,[63] a sample of at least 250 patients (with complete datasets) would be necessary. Most of the published studies comprised fewer subjects. We found in our review 23 original studies on laryngectomees' voice restoration. In only 3 of those studies did the sample size exceed 250.[3] Accordingly, our first conclusion is that we need more comprehensive studies comprising around 300 laryngectomees or more. Preferably, these should be multicenter studies.[13,33]

The second point of interest is that psychosocial and sociodemographic factors are mentioned as frequently as medical and treatment-related factors. It shows that researchers often suppose that these parameters have an impact on the failure or success of gaining a new voice.[5,13,18,39] From a psychotherapeutic point of view, some of the surveyed psychological factors were sometimes not measured appropriately.[25,27,64,65] If one, for instance, wants to know more about the emotional distress of a person, it is not enough to ask simply, "Do you think that you are stable, unstable or variable?"[25] Validated standardized instruments should be used instead; otherwise, the results are not reliable.

It is assumed quite often in clinical practice or in expert opinion[41,47] that lack of motivation is a causal

Table 5. Factors associated with successful voice rehabilitation (summary)

Reference	39	61	47	19	32	36	16	37	27	2	3	14	30	25	40	62	5	52	11	1	18	8	33	13	22	24
N	106	50	ni	49	85	150	10	59	188	152	275	116	60	52	Review	37	63	74	35	63	Review	36	7,008	350	65	95
Sociodemographic & psychosocial factors																										
Age				0	–	–			–		–	–		–											0	–
Social status												0	0											+		
Marital status					+								0													
Employment								+				+			+											
Education				+				0				0														
Social support		0						0					+								+					
Personality				0					+								+									
Intelligence	+		–	0	+																					
Motivation	+		+		+			0			+										+			+		–
Psychosocial adjustment									–					0			+				+					
Communication behavior							+												+	+						
Social activity																		0								
Mental illness		–		–	–			0			–				–											
Alcohol consumption								0						0								0				
Medical & treatment-related factors																										
Speech therapy				0				–			+	0									+		+			
Extension of surgery					0			0				+	0	0							–					
Tumor stage																						0				
Tumor site																						0				
Swallowing problems								–	–					0							–					
Mobility of the tongue								+																		
Type of alaryngeal voice																+					+		+			
Hearing weakness			–		–			0		–		0										0				
Radiation therapy												0		0							–	–		0		
Postoperative complications			–		–			–			–	0												–		
Poor general physical condition			–								–									–	–					–

0 = no correlation; + = positive correlation; – = negative correlation; ni = no information provided.

Table 6. Factors associated with successful voice rehabilitation (consistency of results)

	Consistent results	Uncertain results	Inconsistent results
Positive association	– Active communication – Employment – Type of alaryngeal speech	– Tongue motility – Motivation – Psychosocial adjustment – Personality	– Intelligence – Socioeconomic status – Social support
Negative association	General physical condition	– Age – Depression – Swallowing problems – Complications after surgery	
No association	Alcohol consumption	– Marital status – Social activity – Tumor stage – Tumor site – Hearing weakness – Education – Speech therapy – Extension of surgery – Radiation therapy	

factor of failure. For appropriate measurement of motivation, it is indispensable to define it. Is it a personality trait, or is it related to the social context? Lack of motivation could be due to not being interested in communication, to depression, to feelings of disgust, etc. This should be clarified if one wants to study the relation between motivation and voice rehabilitation.

To date, we do not have enough empirical evidence to claim that psychosocial factors are or are not factors of failure or success in voice rehabilitation after laryngectomy—with the exception of active communication behavior and employment. More prospective studies are needed that analyze psychosocial factors with validated and standardized instruments. Furthermore, it would be helpful to have a consensus within research groups concerning which criteria of voice rehabilitation outcome are the best.

The main conclusions are: (1) it is necessary to define outcome criteria, since this is not consistently done throughout the literature; (2) there is a need to use standardized instruments; (3) we can only vaguely compare results of studies since there is no consensus about instruments and methods. It can be concluded, however, that active communication behavior, employment status, type of alaryngeal speech and the general physical condition are associated with rehabilitation outcomes, whereas alcohol consumption is not.

Quality-of-life research shows that consensus about criteria of success and about instruments is possible, but it requires time and the effort of a group of clinicians, researchers and patients to do this work.[66–68]

Suggestions for Further Studies

Finally, we would like to give some suggestions for future investigation of the issue and for clinical practice.

Criteria of success

If possible, successful voice rehabilitation should be measured in a manifold manner; at least *voice intelligibility* (objective assessment by devices, without eye contact) and *patient's rating of intelligibility* (subjective assessment) should be evaluated. Another good way is to evaluate the *usage* of the alaryngeal voice. Asking about satisfaction with the voice alone is not recommended, as this is partly dependent on the expectations of the patients and their family or friends. A person who expects to speak as well as he did before the operation will be disappointed even if his speech is very good from the therapist's point of view. In such cases, chances are, therefore, that one assesses coping with disease instead of voice rehabilitation success.

Measurement of psychosocial factors

We strictly recommend using validated standardized scales to assess psychosocial factors. This would be especially helpful in reducing false estimations by doctors, who normally are not used to conducting comprehensive psychodiagnostic interviews. For instance, the *Hospital Anxiety and Depression Scale*,[69] a 14-item self-administered instrument, is widely used to assess mental health in medically ill patients. If one wants to evaluate psychiatric comorbidity (depression, alcohol

dependencies, anxiety disorders, etc.), it is necessary to use semistructured clinical interviews, for example the *Structured Clinical Interview for DSM-IV*[70] in cooperation with mental health professionals.

As mentioned above, estimating the impact of motivation on gaining alaryngeal speech would be of great interest for researchers and clinicians. To date, there is a lack of standardized instruments for that specific issue. Moreover, in future studies, motivation should always be assessed *before* the rehabilitation process begins; otherwise, it would not be possible to differentiate between the (real) intention to learn the new voice and the coping process after success or failure of the rehabilitation.[57]

Study design

In order to calculate the impact and interaction of all relevant parameters, it is necessary to conduct multivariate analyses. This requires large sample sizes that are, due to the low incidence of laryngectomies, presumably only possible in multicenter investigations.

Consequences for clinical practice

At the moment, we have very little evidence to assume that motivation is a major prerequisite of successful voice rehabilitation after laryngectomy. Therefore, a clinician should be careful to consider his patient as being "unmotivated" if the rehabilitation fails. Maybe it is also useful to keep in mind that a poor general physical condition is often found to be negatively associated with successful voice rehabilitation and that the amount of alcohol consumption does *not* correspond with rehabilitation outcome. Physicians should encourage laryngectomees to communicate actively, because this would probably help them to gain a good voice. For all further clinical implications, we need more comprehensive prospective studies.

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References

1. Ackerstaff AH, Hilgers FJ, Aaronson NK, Balm AJ. Communication, functional disorders and lifestyle changes after total laryngectomy. *Clin Otolaryngol* 1994;19:295–300.
2. Berger K, Heilmann HP, Heidemüller B. The impact of hearing abilities on esophageal voice. *HNO-Praxis* 1984;9:211–4. [In German]
3. Berger K, Heilmann HP, Diestel H. Injector ventilation in direct laryngoscopy. *Z Erkr Atmungsorgane* 1986;166:213–7. [In German]
4. Berger K, Heilmann HP. Does the use of electronic devices affect the achievement of esophageal voice? *Deutsches Gesundheitswesen* 1984;39:1818–20. [In German]
5. Blood GW, Dineen M, Kauffman SM, Raimondi SC, Simpson KC. Perceived control, adjustment, and communication problems in laryngeal cancer survivors. *Percept Mot Skills* 1993;77:764–6.
6. Bremerich A, Stoll W. Rehabilitation following laryngectomy from the viewpoint of the affected patients. *HNO* 1985;33: 220–3. [In German]
7. Byrne A, Walsh M, Farrelly M, O'Driscoll K. Depression following laryngectomy. A pilot study. *Br J Psychiatry* 1993;163: 173–6.
8. Cantu E, Ryan WJ, Tansey S, Johnson CSJ. Tracheoesophageal speech: predictors of success and social validity ratings. *Am J Otolaryngol* 1998;19:12–7.
9. Daniilidis I, Nikolaou A, Markou C, Kotsani A. Voice rehabilitation after total laryngectomy. Voice prostheses or esophageal replacement voice? *Laryngorhinootologie* 1998;77:89–92. [In German]
10. de Boer MF, Pruyn JF, van den Borne B, Knegt PP, Ryckman RM, Verwoerd CD. Rehabilitation outcomes of long-term survivors treated for head and neck cancer. *Head Neck* 1995;17:503–15.
11. de Maddalena H, Pfrang H. Improvement of communication behavior of laryngectomized and voice-rehabilitated patients by a psychological training program. *HNO* 1993;41:289–95. [In German]
12. Fastenau H, Unruh E, Chilla R. Voice rehabilitation from the viewpoint of the laryngectomized patient. Results of a patient survey. *Laryngorhinootologie* 1994;73:500–4. [In German]
13. Ramirez MJ, Guallart DF, Brotons DS, Carrasco LM, Estelles FE, Lopez MR. Surgical voice restoration after total laryngectomy: long-term results. *Eur Arch Otorhinolaryngol* 2001;258:463–6.
14. Frith C, Buffalo MD, Montague JCJ. Relationships between esophageal speech proficiency and surgical, biographical, and social factors. *J Commun Disord* 1985;18:475–83.
15. Gardner WH. Adjustment problems of laryngectomized women. *Arch Otolaryngol* 1966;83:31–42.
16. Gibbs HW, Achterberg-Lawlis J. The spouse as facilitator for esophageal speech: a research perspective. *J Surg Oncol* 1979; 11:89–94.
17. Heaton JM, Sanderson D, Dunsmore IR, Parker AJ. Speech assessment of patients using three types of indwelling tracheo-oesophageal voice prostheses. *J Laryngol Otol* 1996;110:343–7.
18. Hillman RE, Walsh MJ, Wolf GT, Fisher SG, Hong WK. Functional outcomes following treatment for advanced laryngeal cancer. Part I—Voice preservation in advanced laryngeal cancer. Part II—Laryngectomy rehabilitation: the state of the art in the VA System. *Ann Otol Rhinol Laryngol Suppl* 1998;172: 1–27.
19. Keith RL, Ewert JC, Flowers CR. Factors influencing the learning of esophageal speech. *Br J Disord Commun* 1974;9:110–6.
20. Kesteloot K, Nolis I, Huygh J, Delaere P, Feenstra L. Costs and effects of tracheoesophageal speech compared with esophageal speech in laryngectomy patients. *Acta Otorhinolaryngol Belg* 1994;48:387–94.
21. King PS, Fowlks EW, Peirson GA. Rehabilitation and adaptation of laryngectomy patients. *Am J Phys Med* 1968;47:192–203.

22. Koike M, Kobayashi N, Hirose H, Hara Y. Speech rehabilitation after total laryngectomy. *Acta Otolaryngol* 2002;547(Suppl): 107–12.
23. Kollbrunner J, Gadient MM, Aebischer S, Dobeli P, Zbaren P. Voice rehabilitation after laryngectomy with tracheoesophageal prosthesis. Analysis with special reference to psychosocial factors. *HNO* 1995;43:216–22. [In German]
24. Mäkitie AA, Niemensivu R, Juvas A, Aaltonen L-M, Bäck L, Lehtonen H. Postlaryngectomy voice restoration using a voice prosthesis: a single institution's ten-year experience. *Ann Otol Rhinol Laryngol* 2003;112:1007–10.
25. Mjönes AB, Olofsson J, Danbolt C, Tibbling L. Oesophageal speech after laryngectomy: a study of possible influencing factors. *Clin Otolaryngol* 1991;16:442–7.
26. Mendenhall WM, Morris CG, Stringer SP, Amdur RJ, Hinerman RW, Villaret DB, Robbins KT. Voice rehabilitation after total laryngectomy and postoperative radiation therapy. *J Clin Oncol* 2002;20:2500–5.
27. Natvig K. Laryngectomees in Norway. Study No. 3: Pre- and postoperative factors of significance to esophageal speech acquisition. *J Otolaryngol* 1983;12:322–8.
28. Olthoff A, Mrugalla S, Laskawi R, Fröhlich M, Stuermer I, Kruse E, Ambrosch P, et al. Assessment of irregular voices after total and laser surgical partial laryngectomy. *Arch Otolaryngol Head Neck Surg* 2003;129:994–9.
29. Ramírez MJ, Ferriol EE, Domenech FG, Llatas MC, Suarez-Varela MM, Martinez RL. Psychosocial adjustment in patients surgically treated for laryngeal cancer. *Otolaryngol Head Neck Surg* 2003;129:92–7.
30. Richardson JL, Graham JW, Shelton DR. Social environment and adjustment after laryngectomy. *Health Soc Work* 1989;14: 283–92.
31. Röhrs M, Hambeck G. Early rehabilitation of laryngectomized patients with the electrolarynx? *HNO* 1989;37:100–3. [In German]
32. Sako K, Cardinale S, Marchetta FC, Shedd DP. Speech and vocational rehabilitation of the laryngectomized patient. *J Surg Oncol* 1974;6:197–202.
33. Seinsch W. Laryngectomy—a treatment on the way out? Voice restoration, quo vadis? *Laryngorhinootologie* 2001;80:674–6. [In German]
34. Sens A, Koscielny S, Beleites E. How can speech rehabilitation of laryngectomees be assessed? *Jahrestagung der Norddeutschen Gesellschaft für Otorhinolaryngologie und zervikofaziale Chirurgie*. Oldenburg: NGOzG, 2003:12. [In German]
35. Tsai TL, Chang SY, Guo YC, Chu PY. Voice rehabilitation in laryngectomees: comparison of daily-life performance of 4 types of alaryngeal speech. *J Chin Med Assoc* 2003;66:360–3.
36. Van De Calseyde P, Ampe W, Depondt M, Wynants E. Social rehabilitation of the laryngectomy patient. *Verh K Acad Geneeskd Belg* 1975;37:103–51. [In Dutch]
37. Volin RA. Predicting failure to speak after laryngectomy. *Laryngoscope* 1980;90:1727–36.
38. Ward EC, Koh SK, Frisby J, Hodge R. Differential modes of alaryngeal communication and long-term voice outcomes following pharyngolaryngectomy and laryngectomy. *Folia Phoniatr Logop* 2003;55:39–49.
39. Zakrzewski A, Pruszewicz A. On factors facilitating the development of speech rehabilitation in patients after laryngectomy. *Otolaryngol Pol* 1968;22:519–26. [In Polish]
40. Bronheim H, Strain JJ, Biller HF. Psychiatric aspects of head and neck surgery. Part I: New surgical techniques and psychiatric consequences. *Gen Hosp Psychiatry* 1991;13:165–76.
41. Happ MB, Roesch T, Kagan SH. Communication needs, methods and perceived voice quality following head and neck surgery. *Cancer Nurs* 2004;27:1–9.
42. Simpson CB, Postma GN, Stone RE, Ossoff RH. Speech outcomes after laryngeal cancer management. *Otolaryngol Clin North Am* 1997;30:189–205.
43. Breuninger H. Rehabilitation after laryngectomy. *Laryngol Rhinol Otol (Stuttg)* 1982;61:267–71. [In German]
44. Jassar P, England RJ, Stafford ND. Restoration of voice after laryngectomy. *J R Soc Med* 1999;92:299–302.
45. Löbe L-P. Speech rehabilitation after laryngectomy by voice prosthesis. Principles, results and problems. *Otolaryng Pol* 1990; 44:181–2. [In German]
46. Perry A. The role of the speech and language therapist in voice restoration after laryngectomy. *J Laryngol Otol* 1997;111:4–7.
47. Spiecker-Henke M. Therapeutic problems in learning oesophageal speech. *Z Laryngol Rhinol Otol* 1972;51:821–4.
48. Thompson E. The silent voice. *Lancet* 1982;320:1268–9.
49. Berger K, Heilmann HP. Esophageal voice and specialized rehabilitation for laryngectomies. *Deutsches Gesundheitswesen* 1983;38:150–4. [In German]
50. Hagen R. Voice rehabilitation after total laryngectomy in West Germany. Current state of the art. *HNO* 1990;38:417–20. [In German]
51. del Rio Valeiras M, Martin MC, Perez-Carro RA, Minguez BI, Rodriguez MC, Bravo JE, Labella CT. A study of the factors that may affect rehabilitation using the esophageal voice method in total laryngectomy. *Acta Otorrinolaringol Esp* 2002;53:413–7. [In Spanish]
52. de Maddalena H, Maassen M, Arold R, Ptok M, Zenner HP. Voice rehabilitation after laryngectomy with voice prostheses. Results of a prospective follow-up study. *Laryngorhinootologie* 1992;71:416–22. [In German]
53. de Maddalena H, Zenner HP. Evaluation of speech intelligibility after prosthetic voice restoration by a standardized telephone test. In: Algaba J, ed. *Surgery and Prosthetic Voice Restoration After Total and Subtotal Laryngectomy*. Amsterdam: Elsevier, 1996:183–7.
54. Ptok A, de Maddalena H, Plinkert PK, Arold R. Relations between objective parameters for measuring voice, aspects of psychosocial adjustment, and subjective voice assessment in patients with partial resection of the larnyx. *Sprache-Stimme-Gehör* 1992;16:38–42. [In German]
55. Ptok M. Objective voice assessment following operation of the larynx in cancer patients. *Sprache-Stimme-Gehör* 1990;14:11–7. [In German]
56. Schuller DE, Trudeau M, Bistline J, LaFace K. Evaluation of voice by patients and close relatives following different laryngeal cancer treatments. *J Surg Oncol* 1990;44:10–4.
57. Bindewald J, Herrmann E, Dietz A, Wulke C, Meister EF, Wollbrück D, Singer S. Quality of life and voice intelligibility in laryngeal cancer patients—relevance of the "satisfaction paradox". *Laryngorhinootologie* 2007;86:426–30. [In German]
58. Quer M, Burgues-Vila J, Garcia-Crespillo P. Primary tracheoesophageal puncture vs esophageal speech. *Arch Otolaryngol Head Neck Surg* 1992;118:188–90.
59. Schultz-Coulon HJ. Rehabilitative methods for the laryngectomized patient—new orientation for the practice. *HNO* 1984; 32:3–12. [In German]
60. Williams SE, Scanio TS, Ritterman SI. Perceptual characteristics of tracheoesophageal voice produced using four prosthetic/occlusion combinations. *Laryngoscope* 1990;100:290–3.
61. Siegel E, König K, Heidrich R. Socio-psychiatric problems of laryngectomized patients. *Psychiatr Neurol Med Psychol* 1969;21:330–6. [In German]
62. de Maddalena H, Pfrang H, Schohe R, Zenner HP. Speech intelligibility and psychosocial adaptation in various voice rehabilitation methods following laryngectomy. *Laryngorhinootologie* 1991;70:562–7. [In German]

63. Bender R, Ziegler A, Lange S. Multiple regression. *Dtsch Med Wochenschr* 2007;132(Suppl):e30–2. [In German]
64. Werner E, Berger K, Heilmann HP. Psychosocial aspects and rehabilitation problems of patients with tumors of the ORL region with special reference to laryngectomees. *Arch Geschwulstforsch* 1989;59:19–22. [In German]
65. Gibson AR, McCombe AW. Psychological morbidity following laryngectomy: a pilot study. *J Laryngol Otol* 1999;113:349–52.
66. Fayers P, Hopwood P, Harvey A, Girling DJ, Machin D, Stephens R. Quality of life assessment in clinical trials—guidelines and a checklist for protocol writers: the U.K. Medical Research Council experience. MRC Cancer Trials Office. *Eur J Cancer* 1997;33:20–8.
67. Wyrwich KW, Bullinger M, Aaronson N, Hays RD, Patrick DL, Symonds T; The Clinical Significance Consensus Meeting Group. Estimating clinically significant differences in quality of life outcomes. *Qual Life Res* 2005;14:285–95.
68. Sprangers MA, Cull A, Bjordal K, Gronvold M, Aaronson NK. The European Organization for Research and Treatment of Cancer. Approach to quality of life assessment: guidelines for developing questionnaire modules. EORTC Study Group on Quality of Life. *Qual Life Res* 1993;2:287–95.
69. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand* 1983;67:361–70.
70. Boehmer U, Clark JA. Communication about prostate cancer between men and their wives. *J Fam Pract* 2001;50:226–31.