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MISCELLANEOUS

Outcome and survival following tracheostomy in patients ≥ 85 years old

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Abstract

Purpose To evaluate percutaneous dilatational tracheostomy in patients ≥ 85 years old: its complication rate and possible risk factors. In addition, to assess prognostic factors for short, intermediate and long term survival following the procedure.

Methods A retrospective case–control study of 72 patients ≥ 85 years who received percutaneous dilatation tracheotomy (PTD), compared to a control group of younger patients ($n = 182$). Demographics, clinical and laboratory data were collected. Survival and risk for complications were analyzed.

Results The study group's mean age was 89 ± 4. Twelve patients had complications, three (4.2%) were major. No significant difference was found in overall complication rates between the groups. Cerebrovascular disease with neurologic deficits and pre-procedure albumin levels were significantly associated with complications. Survival rates did not differ in 1 week and 1 month following procedure between study and control group. There was a significant difference in the 1-year survival rates between the patients ≥ 85 years and the control groups (18.1% vs. 34.4%, $p = 0.01$, respectively). Congestive heart failure, a frailty score > 0.27 and failure to wean from a cannula were associated with reduced 1-year survival.

Conclusion PTD is safe for patients ≥ 85 years. Complication risk factors and reduced survival should be discussed with patients and families before conducting tracheostomies.

Level of evidence 3b.

Keywords Tracheostomy · Percutaneous · Oldest of old · Complications · Survival · Prognosis

Introduction

The oldest of old population is defined as people aged 85 years and older [1]. The proportion of those ≥ 80 years is projected to double till 2050 up to almost 10% of the population [2, 3], resulting in a larger proportion of this population in the intensive care units (ICU) and its stepdown units [4, 5]. The common prevalence of multimorbidity among octogenarians [6] mandates special considerations for optimal treatment.

Percutaneous dilatational tracheostomy (PDT) is a well-established procedure, which has been shown to be both safe and cost effective [7]. It has been shown to be safe even under suboptimal conditions when conducted at the bedside in ICU-stepdown units [8]. To date, only a few studies focused on the safety and outcome of tracheostomy in elderly patients [9] and even fewer in the oldest of old [10]. The procedure in this study was found to be safe, with a 4.7% complication rate, yet PDT was only performed in 12.5% of the patients. Ethical questions regarding the need of tracheostomy in severely ill elderly patients have been raised by Baskin et al. [11], who found that the majority of these patients are not expected to be weaned or de-cannulated.

The aim of this current study is to analyze the safety and prognosis of bedside-PDT (BPDT) in the oldest of old patients, compared with younger patients. Identification of possible risk factors for poor survival post-BPDT

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in the oldest of old patients will improve counseling to both patients and families. To the best of our knowledge, this is the first case–control study to do so.

Patients and methods

After approval by the Kaplan Medical Center's Review Board and Ethical Committee, the electronic data of all patients who underwent BPDT in the medical wards at our institution between September 2009 and December 2015 (inclusive) were collected. Patients were selected based on the BPDT logbook, which included all performed procedures. Exclusion criteria included patients with missing substantial pertinent data (detailed below).

Our outreach BPDT unit and BPDT protocol were described in detail in a previous publication [8], which is based on similar principles of other institutions' multidisciplinary PDT team [7]. Contraindications for BPDT was determined by pre-procedural physical examination of an otolaryngologist and systemic evaluation by an intensive care specialist [8]. BPDTs were performed using a Portex® ULTRAperc® Single Dilator Technique Kit with a Blue Line Ultra® Tracheostomy tube kit (Smith Medical, Ashford, Kent, UK). All patients undergoing a tracheostomy had a Portex® (Smith Medical, Ashford, Kent, UK), non-fenestrated cuffed tracheostomy tube, with 8 mm inner diameter.

The study's follow-up period was defined as 1 year following BPDT, de-cannulation or death. The study's main outcomes were defined as complications and survival following BPDT. Complications were categorized into early ($\leq$24 h following PDT) and late (>24 h), minor and major. Minor complications included minor bleeding and local infections. Major complications included any airway complication ($\pm$resuscitation), major bleeding (necessitating blood products or intervention), pneumothorax/mediastinum, tracheoesophageal fistula, and related infections resulting in sepsis.

Post-procedural survival was regarded as a continuous variable, and was also categorized in the following matter: survival 1 week/1 month and 1 year following the procedure. The intervals were chosen based on previous studies and published life expectancies of elderly multi-morbid patients [12–14].

Additional data included age, gender, indication for admission (infectious, respiratory failure, cardiovascular, neurological, admission for surgery, and miscellaneous). Pre-operative comorbidities included: diabetes, functional dependenc (determined by the nursing staff report), respiratory comorbidities, congestive heart failure (CHF), ischemic heart disease (IHD) and other cardiac comorbidities, hypertension, peripheral vascular disease (PVD), impaired sensorium, and cerebrovascular disease with or without deficit. Laboratory results included: creatinine levels, hemoglobin levels (g/dL), and albumin levels (g/dL). Thrombocytopenia was defined as a platelet count lower than 150 K/μL. Other relevant data included pre-operative fever (temperature $\geq$38.0), inotropic support and resuscitation prior to procedure, time from hospitalization to ventilation, time from ventilation to BPDT, and time from request by the ward for PDT to its execution. Frailty score was based on previous publications, with a score >0.27 being the cutoff between low and high risk patients [13].

Statistical analysis

Categorical variables were reported by prevalence and percentages, and continuous variables were reported as means and standard deviation or as medians and range. Association of categorical variables was done using Pearson's Chi-square test. Continuous variables were tested for normal distribution, and were tested by a Mann–Whitney test. Two-tailed analyses with p value of 0.05 or less were considered statistically significant. Odds ratio (OR) and relative risk were calculated for significant associations. Analyses were performed with SPSS (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

Results

A total of 254 patients underwent PDT in our institution and were included in this study, of which 72 patients (28.3%) were 85 years and older and comprised the study group. Differences between the study and control groups are presented in Table 1. The mean age of the study group is 89 ($\pm$4) years, compared with 73 ($\pm$11) years of the control group ($p<0.001$). There were 23 (31.9%) males in the study group compared with 82 (45.1%) in the control group ($p=0.056$). The proportion of oldest of old patients defined as functionally depended was significantly higher compared with the control (91.5% vs. 81.3%, $p=0.045$, respectively) and had lower rates of respiratory comorbidities (62.5% vs. 76.9%, $p=0.02$, respectively). Borderline significance was found in renal insufficiency (1.37 creatinine vs. 1.09, $p=0.05$, respectively) and inotropic support prior to procedure (5.6% vs. 1.6%, $p=0.086$).

Twelve patients (16.7%) in the study group had complications following PDT. Three of these patients (4.2%) had major complications: one patient had early major bleeding and two patients had airway obstructions resulting resuscitation on postoperative day (POD) 4 and 18. No significant differences were found in the overall complication rate and in its subgroup analysis (major/minor, early/late; Table 2) between the study and control groups. The mean duration

Table 1 Pre-procedure comparisons: demographics, comorbidities, health status and ventilation of the study groups

	< 85 ($n=182$)	≥ 85 ($n=72$)	p value
Age			
Mean, years (SD)	73 (11)	89 (4)	< 0.001
Gender			
Male	82 (45.1)	23 (31.9)	0.056
Admission indication			
Respiratory failure	41 (22.5)	15 (20.8)	NS
Cardiovascular	29 (15.9)	10 (13.9)	
Infections	70 (38.5)	26 (36.1)	
Neurology	15 (8.2)	10 (13.9)	
Surgery	18 (9.9)	9 (12.5)	
Other	9 (4.9)	2 (2.8)	
Pre-operative co-morbidities			
Frailty score* < 0.27	5 (6.9)	19 (10.4)	NS
Diabetes	73 (40.1)	28 (38.9)	NS
Functional dependent (nurse)	148 (81.3)	65 (91.5)	0.045
Respiratory complaint	140 (76.9)	45 (62.5)	0.02
Congestive heart failure	52 (28.6)	22 (30.6)	NS
Myocardial infarction	40 (22)	17 (23.6)	NS
Other cardiac comorbidity	39 (21.4)	17 (23.6)	NS
Hypertension	118 (64.8)	51 (70.8)	NS
Peripheral vascular disease	23 (12.6)	12 (16.7)	NS
Impaired sensorium	131 (72)	52 (72.2)	NS
Cerebrovascular disease	71 (39)	27 (37.5)	NS
Cerebrovascular disease with deficit	64 (35.2)	23 (31.9)	NS
Laboratory			
Creatinine (mean)	1.09	1.37	0.05
Hypoalbuminemia	179 (98.9)	71 (100)	NS
Thrombocytopenia	16 (8.8)	7 (9.7)	NS
Other			
Pre-operative fever	18 (9.9)	9 (12.5)	NS
Inotropic support prior procedure	3 (1.6)	4 (5.6)	0.086
Resuscitation prior to procedure	36 (19.8)	12 (16.7)	NS
Time ventilation to PDT (days)	21	21	NS
Time request to perform (days)	4	2.8	0.002
Time request to perform (days)	4	2.8	0.002

Data is presented in n (%) unless specified otherwise

*Frailty score based on Johnson et al. [13]

NS non-significant

of survival following the procedure was significantly shorter among the oldest of old compared to the control group (223 days vs. 412, $p=0.021$). No statistical difference was found in the survival rate of 1 week and 1 month following PDT between the study and the control groups (Table 2). There was a significant difference in the 1-year survival rates between the oldest of old and the control groups (18.1% vs. 34.4%, $p=0.01$, respectively, Fig. 1).

Next, we analyzed possible risk factors for PDT complications among the oldest of old (Table 3). Cerebrovascular disease with a neurologic deficit was significantly more prevalent in oldest of old patients with complications following tracheostomy compared with those without (58.3% vs. 26.7%, $p=0.032$). Pre-procedure albumin levels were significantly lower in oldest of old patients with complications compared with those without (2.1 [± 0.4] vs. 2.5 [± 0.4], $p=0.025$). A frailty score > 0.27 demonstrated a borderline significance (91.7% in patients with complications vs. 66.7% in patients without, $p=0.082$).

Finally, we conducted an analysis of survival among patients aged ≥ 85 years. By POD 37, a 50% survival was seen. One quarter of the patients was alive 6 months

Table 2 Complication, outcome and survival following bedside percutaneous dilatational tracheostomy

	< 85 ($n = 182$)	≥ 85 ($n = 72$)	p value
Complications			
Complications overall	34 (18.7)	12 (16.7)	NS
Major complications	10 (5.5)	3 (4.1)	NS
Major immediate complications*	5 (2.7)	1 (1.4)	NS
Major late complications**	5 (2.7)	2 (2.8)	NS
Minor complication: local infection	13 (7.1)	5 (6.9)	NS
Minor complication: minor bleeding	11 (6)	4 (5.6)	NS
Cannula weaning	11 (6)	1 (1.4)	NS
Outcome			
Transfer other medical institution	107 (58.8)	40 (55.6)	NS
Mortality during hospitalization	67 (36.8)	30 (41.7)	NS
Mortality and Survival			
Mortality due to AW	2 (2)	1 (2.5)	NS
Mean survival time after procedure or end of follow-up (days)	412	223	0.021
Survival 1 week	159 (88.3)	64 (88.9)	NS
Survival 1 month	124 (68.9)	43 (59.7)	NS
Survival 1 year	62 (34.4)	13 (18.1)	0.01

Data is presented in n (%) unless specified otherwise

NS non-significant, *AW* airway

*Defined as any complication ≤ 24 h following procedure; **Defined as any complication > 24 h following procedure

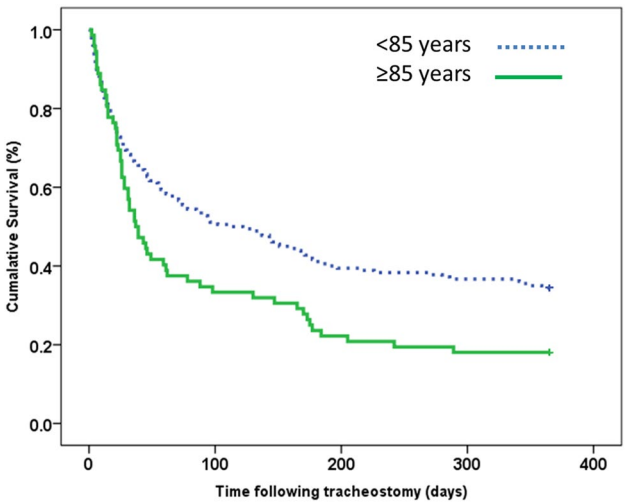

Fig. 1 Kaplan–Meier 1-year survival plot. One-year survival plots between study group (oldest of old, green line) and control group (blue line). One-year survival rates were significantly lower in the oldest of old compared with the control group (18.1% vs. 34.4%, p value = 0.006, Log Rank [Mantel-Cox]). *p value < 0.05

following PDT (Fig. 1). Risk factors for different survival durations following PDT in the study group are presented in Table 3 and odds ratio in Table 4. Increased creatinine level > 1.8 mg/dL, CHF, non-CHF/IHD cardiac comorbidities and pre-operative fever were all associated with reduced survival rate of 1 week following PDT, with an odds ratio (OR) of 2.91 (CI 1.21–6.99), 2.35 (CI 1.2–4.62), 3.33 (CI 1.59–6.99) and 4.0 (CI 1.23–12.95), respectively. Reduced survival of 1 month following the procedure was significantly associated with creatinine levels > 1.8 (OR 2.97; CI 1.13–7.78), CHF (OR 3.18; CI 1.48–6.89), non-CHF/IHD cardiac comorbidities (OR 3.56; CI 1.40–9.03) and PVD (OR 2.97; CI 0.98–8.94). Borderline significance was noted for IHD ($p = 0.074$). Reduced survival of 1 year following the procedure was significantly associated with CHF (OR 4.63; CI 0.68–31.37), a frailty score > 0.27 (OR 1.653; CI 0.90–3.02) and failure to wean from cannula (no patients vs. one patient $p = 0.032$, OR not feasible).

Discussion

In this study, we investigated the outcome of bedside PDT in the oldest of old (≥ 85 years) patients. Analysis of the data showed no increased risk for complications when compared to the control group. Different risk factors were found for 1 week, 1 month and 1 year following the procedure.

Table 3 Significant associations of pre- and post-procedural factors with survival

	Survival 1 week			Survival 1 month			Survival 1 year		
	No *n* (%)	Yes *n* (%)	*p* value	No *n* (%)	Yes *n* (%)	*p* value	No *n* (%)	Yes *n* (%)	*p* value
Creatinine (mg/dl); mean (SD)	2.42 (1.97)	1.23 (1.22)	0.023	1.75 (1.61)	1.11 (1.10)	NS	1.151 (1.45)	0.73 (0.36)	NS
Congestive heart failure	5 (62.5)	17 (26.6)	0.037	15 (51.7)	7 (16.3)	< 0.001	21 (35.6)	1 (7.7)	0.048
Ischemic heart disease	4 (50)	13 (20.3)	0.062	10 (34.5)	7 (16.3)	0.074	16 (27.1)	1 (7.7)	NS
Other cardiac co-morbidities	5 (62.5)	12 (18.7)	0.006	12 (41.4)	5 (11.6)	0.004	16 (27.1)	1 (7.7)	NS
Peripheral vascular disease	1 (12.5)	11 (17.2)	NS	8 (27.6)	4 (9.3)	0.041	11 (18.7)	1 (7.7)	NS
Resuscitation prior to procedure	3 (37.5)	9 (14.1)	0.094	6 (20.7)	6 (14)	NS	10 (16.9)	2 (15.4)	NS
Pre-operative fever	3 (37.5)	6 (9.4)	0.023	4 (13.8)	5 (11.6)	NS	7 (11.9)	2 (15.4)	NS
Frailty > 0.27**	6 (75)	45 (70.3)	NS	23 (79.3)	28 (65.1)	NS	45 (76.3)	6 (46.2)	0.031
Cannula weaning	0 (0)	1 (1.6)	NS	0 (0)	1 (2.3)	NS	0 (0)	1 (7.7)	0.032

All data presented in *n* (%) unless otherwise specified

s\p status post, *NS* non-significant

**Frailty score based on Johnson et al. [13]. All factors analyzed with *p* value ≥ 0.1 were excluded from this table: gender, admission indication, hemoglobin levels, albumin levels, anemia, thrombocytopenia, hypoalbuminemia, complications (divided to total, major and minor), hypertension, impaired sensorium, diabetes, cerebrovascular disease, respiratory problems, inotropic support prior procedure and nurse-wise independency

Table 4 Odds ratio for factors associated with reduced survival

	Survival 1 week OR (CI 95%)	Survival 1 month OR (CI 95%)	Survival 1 year OR (CI 95%)
Creatinine (1.8 +)	2.91 (1.21–6.99)	2.97 (1.13–7.78)	–
Congestive heart failure	2.35 (1.2–4.62)	3.18 (1.48–6.89)	4.63 (0.68–31.37)
Other cardiac co-morbidities	3.33 (1.59–6.99)	3.56 (1.40–9.03)	–
Peripheral vascular disease	–	2.97 (0.98–8.94)	–
Fever	4.0 (1.23–12.95)	–	–
Frailty > 0.27**	–	–	1.653 (0.90–3.02)

**Frailty score based on Johnson et al. [13]

Complications

Octogenarians are prone to higher complication rates in other head and neck surgeries [14], yet few studies focused on tracheostomy complications in this subgroup of patients. Drendel et al. [10] reported a 4.7% ($n = 64$) complication rate, and no tracheotomy-related deaths, though PCT was only conducted in 12.5% of the cohort. All complications were defined as major based on this study's classification. Minor complications were not collected. In our study, major complications were found in 4.2%, to the same as the control group. Even though elderly patients may have a friable membranous part of the trachea which is susceptible to tearing, posterior tracheal wall injury was no documented in this group. This should be noticed as some reports have reported an increased incidence of the latter using PDT technique [15]. It is possible that these early reports of increased posterior wall tear in PDT technique have led to a better awareness and caution by current PDTs teams. Cerebrovascular diseases with neurologic deficits and pre-procedure albumin levels were significantly associated with complications among this subgroup of patients, with a borderline significance noted in patients with a frailty score > 0.27. Previous studies on the impact of age on complications following major head and neck surgeries found that age alone was not a prognostic factor, but comorbidities were found to predict complications [16, 17]. A multi-center study on tracheostomy complications found that the patient's history,

including comorbidities, did not affect the rate of complications, yet specific comorbidities were not assessed [18]. Altogether, it seems age alone does not pose an increased risk for PDT complications, but comorbidities, such as low albumin levels and CVA history do. To the best of our knowledge, we are the first to examine risk factors for PDT complications in the oldest of old population. Patients with aforementioned comorbidities, and their families, should be advised regarding the increased risk, as part of a principle decision regarding the benefits and aims of the procedure (see below).

Survival and outcome

In-hospital mortality rates for the severely ill oldest of old range in different reports from 30 to 56% [10, 11, 19, 20], with oldest of old being defined differently in these reports. Rellos et al. [21] studied critically ill patients aged ≥ 90 years, and found an in-hospital mortality rate of 40%, of which 91.7% died within 30 days following ICU discharge. Regardless of tracheostomy, older age was found to increase ICU/in-hospital mortality by some [9, 22], but not by all authors [19]. The in-hospital mortality rate in our study was 41.7% among patients aged ≥ 85 years, well within the reported range, with no difference found compared to the control group. The overall 1-year survival rate was 18%. This can be explained by the overall morbidity of these patients, reflected in their list of ailments and their overall frailty score (Table 1). Moreover, mechanical ventilation is known to increase mortality among patients ≥ 85 years, reaching 67% for patients aged 85–89 years and 75% among patients ≥ 85 years [12]. Unlike short term prognosis following PDT, 1-year survival seems to relate to the function of older patients, and the lack of reserves to recover rather than the percutaneous tracheostomy procedure.

An important contribution of this study is the attempt to find possible factors which are associated with reduced survival. Cardiovascular comorbidities and CHF in particular, have been found to have a great impact on survival, mostly 1 week and month following PDT. Sagiv et al. [23] found that IHD was associated with postoperative complications among octogenarians. Renal insufficiency has been shown to reduce long term prognosis in patients with prolonged mechanical ventilation [20, 24]. A creatinine ≥ 1.8 was found significant on a multivariate analysis for both 1 week and month survival. Similarly, Zhang et al. [25] have shown than reduced albumin, CHF and renal insufficiency were associated with reduced 1-year survival in hospitalized oldest of old patients. Pre-operative fever has been shown to impact immediate survival, and therefore, we suggest that tracheostomies should be reconsidered if the patient had fever in the days prior to the procedure.

Knowledge of such factors may have important contributions for deciding whether a tracheotomy should be performed. The risk for a worse prognosis should be considered together with other elements such as the patient's or family's wishes, nursing care and economic considerations. This will be elaborated on in the following section.

Ethical concerns

The discussion regarding tracheostomy in the oldest of old is both medical and ethical. The proportion of octogenarians is expected to rise as medical treatments progress. It is the most rapidly expanding segment of the population [21], reflecting the proportion of mechanical ventilation needed as well [4, 5].

When compared to an endolaryngeal tube, breathing through a tracheostomy tube offers several benefits for the patients, such as reduced work of breathing, decreased laryngeal injuries and stenosis, and reduced use of analgesia/sedative drugs as well as improvement of the nursing care [26].

Baskin et al. [11] raised questions regarding the 'automatization' of performing tracheostomies in the fragile elderly patients. They found that most expectations from tracheostomy (ventilation weaning, decannulation and improvement in quality of life) were not met in the elderly severely ill patients. In their comments to the article, the editors emphasized that patients and family will need to take a critical look at the patient's prognosis and the likely outcomes. Our study adds important information on this forthcoming challenge for all health providers. It is our belief that besides medical and nursing advantages, tracheostomy benefits with the patient's and family's perception of the patient, offering palliative end of life care, and therefore, should be considered even in patients with grave prognoses.

Our experience has taught us that tracheostomy offer benefits which are difficult to be quantified and measured, yet should be considered nevertheless. Families have reported to our team that they felt it was more respectful for the patient to breath from the trachea, thereby 'remembering' the patient's face as it was before. Considering the acceptable rate of complications, this should also be taken into account when discussing the option of tracheostomy with the patients' surrogates.

We agree with the previous studies [3, 11, 23, 27] that it is vital before performing a tracheotomy in severely ill elderly patients to have an open and honest conversation with the patient (if possible) together with the patient's family, defining the goals for the procedure and clarifying expectations from both sides.

Limitations

The study is a retrospective cohort study, thus there is the possibility of missing data and inaccurate documentation. Data for open tracheostomies were not collected, since less than 10% were open tracheostomies in our institution. Therefore, their exclusion is reasonable and may prevent a potential treatment bias between the groups. Finally, outcomes of the study did not relate to the patients' functional outcome and quality of life, which is an extremely important issue in chronically ill geriatric patients. We were not able to collect the number of patients who remained with tracheostomies but without ventilation. This should be emphasized in future studies.

Conclusions

PDT is a safe procedure in the oldest of old patients. Caregivers should be aware of potential risk factors for complications and for poor prognosis in this subgroup of patients. These factors should be taken into consideration when discussing the need for tracheostomies and their outcomes.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Kaplan Medical Center's Review Board and Ethical Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards".

Research involving human participants This article does not contain any studies with human participants performed by any of the authors.

Informed consent Informed consent was not obtained due to the anonymous retrospective data collection and analysis, as approved by the institutional ethical committee.

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