Original Article

Activities of daily living and psychiatric symptoms after intensive care unit discharge among critically ill patients with or without tracheostomy: a single center longitudinal study

Mami Shibata,[1] Kyohei Miyamoto,[1] Nozomu Shima,[1] Tsuyoshi Nakashima,[1] Kosei Kunitatsu,[1] Takafumi Yonemitsu,[1] Atsumi Kawabata,[2] Yutsuki Kishi,[2] and Seiya Kato[1]

[1]*Department of Emergency and Critical Care Medicine, Wakayama Medical University, Wakayama, Japan, and* [2]*Department of Nursing, Wakayama Medical University Hospital, Wakayama, Japan*

Aim: Tracheostomy is widely performed in critically ill patients who require prolonged mechanical ventilation. Long-term morbidity (post-intensive care syndrome) in tracheostomized patients is not widely reported, however, so we evaluate it here.

Methods: This is a sub-analysis of a single center prospective longitudinal study, which assessed activities of daily living (ADL) and psychiatric symptoms in adult patients emergently admitted to the intensive care unit (ICU). We evaluated association between these symptoms and tracheostomy by posting questionnaires at 3 and 12 months after ICU discharge.

Results: We analyzed 107 patients (15 patients with tracheostomy) at 3 months and 74 patients (13 patients with tracheostomy) at 12 months after ICU discharge. ADL tended to be lower in patients with tracheostomy than in those without tracheostomy at 3 months after ICU discharge (65 [10–100] versus 95 [59–100]; P = 0.28, 7/15 [47%] versus 30/102 [30%] Barthel Index scored ≤ 60; P = 0.23), however there were no significant differences. Psychiatric symptoms were not different between the groups at 3 months and again at 12 months.

Conclusion: Activities of daily living disability and psychiatric symptoms were not significantly worse in patients with tracheostomy at 3 and 12 months from ICU discharge compared with patients without tracheostomy. Despite the limited number in our cohort, our study may inform shared decision making concerning tracheostomy for critically ill patients and their families.

Key words: Activities of daily living, decision-making, post-intensive care syndrome, psychiatric symptoms, tracheostomy

BACKGROUND

TRACHEOSTOMY IS PERFORMED in ~10% of patients with whole mechanical ventilation in critical illness because of prolonged mechanical ventilation or airway-patency problems.[1] The number of patients undergoing tracheostomy has been increasing since the development of a bedside percutaneous tracheostomy technique.[2] Poor long-term survival and functional outcomes in these tracheostomized patients have been reported in several studies and the 1-year mortality rate is reported to be extremely high, 45%–60%.[3–5] Regarding physical function, an observational study reported that 98% of patients that underwent prolonged mechanical ventilation had poor physical function at admission to a long-term care hospital; totally bedridden or in bed more than half of the day, and 40% of patients continued to have poor physical function after a year.[6] Elsewhere, physical function in tracheostomized patients was limited even after several years.[7,8] In contrast, long-term mental health impairments have different results. Depression was present in 32%–42% of patients that received prolonged mechanical ventilation.[7,9] By contrast, comparatively few tracheostomized patients had long-term mental health problems in other studies.[8,10,11] Post-intensive care syndrome (PICS) comprises several domains, including physical, cognitive, and mental problems, which may lead to such

Corresponding: Mami Shibata, MD, Department of Emergency and Critical Care Medicine, Wakayama Medical University, 811-1 Kimiidera, Wakayama City, Wakayama, Japan. E-mail: mami517@wakayama-med.ac.jp.

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disparity in results. Knowledge about elements of PICS is still limited, however, such as the difference between long-term physical functional prognosis and mental health problems in tracheostomized patients. Some studies have evaluated health-related quality of life (QOL),[7,8,10] but few have evaluated activity of daily living (ADL)[7,12] or psychiatric symptoms such as depression, anxiety, or post-traumatic stress disorder (PTSD) in tracheostomized patients.[9,11]

Collective decisions on tracheostomy between physicians and patients should be based on the shared prediction of prognosis, not only survival, but also the long-term physical functional status or mental health. Furthermore, intensive care unit (ICU) patients are often elderly and can have difficulty making decisions on their own, so there are greater instances of surrogate decision making.[13] Information about the long-term physical functional status or mental health is especially crucial in such a situation. This study aims to reveal PICS symptoms including disabled ADL and psychiatric symptoms such as depression, anxiety, or PTSD among tracheostomized patients during critical illness.

METHODS

THIS IS A sub-analysis of Wakayama post-intensive care syndrome (W-PICS) study, a single center prospective longitudinal study.[14] W-PICS-study was approved by the Wakayama Medical University Ethics Committee (approval no. 1864), and was registered to the UMIN Clinical Trial Registry, UMIN000023743 (Registered on September 1, 2016, https://upload.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000027346). Written informed consent was obtained from patients or substitute decision makers.

The W-PICS study enrolled 204 patients between September 2016 and August 2018. We enrolled patients ages 20 years or older who were emergently admitted to our ICU, with the exception of patients who were expected to die within 48 h. The epidemiology of PICS, ADL disability, and psychiatric symptoms such as depression, anxiety, and PTSD at 3 and 12 months after ICU discharge was discerned by posted questionnaires. ADL disability was evaluated by the Barthel index (BI),[15] depression and anxiety by Hospital Anxiety and Depression Scale (HADS),[16] and PTSD by Impact of Event Scale-Revised (IES-R),[17] respectively. The main results have been published elsewhere.[14]

In this sub-analysis, we included patients that responded to questionnaires at 3 and 12 months after ICU discharge. The analyzed patients were divided into those who underwent tracheostomy (tracheostomy group) and those that did not (non-tracheostomy group). In our institution, tracheostomy was performed when patients were expected to require prolonged mechanical ventilation, or if the airway needed to be protected because of coma or airway obstruction. Tracheostomy group comprised the patients that underwent tracheostomy during their hospital stay. Indication for tracheostomy was discussed and decided by the attending team of physicians.

The primary outcome was disability affecting ADL and psychiatric symptoms in the tracheostomy group compared with the non-tracheostomy group at 3 and 12 months after discharge from ICU. We also described change in each basic component of ADL in BI score from 3 to 12 months after ICU discharge in the tracheostomy group. ADL was measured using BI score consisting of 10 items: feeding, bathing, grooming, dressing, bowels, bladder, toilet use, transfers (bed to chair and back), mobility (on level surfaces), and stairs.[15] BI score ranges from 0 (completely dependent patients) to 100 (independent patients). We defined ADL disability as BI score ≤ 60.[18] Depression and anxiety symptoms were measured using the respective subscale of HADS (HADS-Depression and HADS-Anxiety).[16] Each subscale ranges between 0 and 21, higher score indicating worse symptoms with a cutoff value of ≥ 8 indicating the presence of symptoms of anxiety or depression.[19] PTSD was measured using IES-R ranging between 0 and 88, and the higher score indicating worse symptoms[17] with a cutoff value of ≥ 25 indicating the presence of significant PTSD symptoms.[20]

Statistical analysis

Continuous variables are presented as median and interquartile range (IQR); categorical variables are presented as numbers and percentages (%). For comparison of the two groups, Wilcoxon rank sum test was used for continuous variables and χ^2 test was used for categorical variables to compare between the two groups. However, we used Fisher's exact test. Fisher's exact test was used for comparison with cells with an expected frequency ≤ 5. A two-sided P value <0.05 was considered to be statistically significant, and all analyses were performed using JMP Pro Software (version 13.0.0; SAS Institute Inc., Cary, NC).

RESULTS

OF 204 PATIENTS enrolled, 29 underwent tracheostomy during their hospital stay. We excluded the patients that died within 12 months, those that withdrew consent, and those that met exclusion criteria. We, therefore, analyzed 117 patients (15 patients in the tracheostomy group) at 3 months, and 74 patients (13 patients in the tracheostomy group) at 12 months after ICU discharge. (Fig. 1).

Table 1 shows baseline demographics and clinical characteristics. The median age of patients was 71 years (60–78),

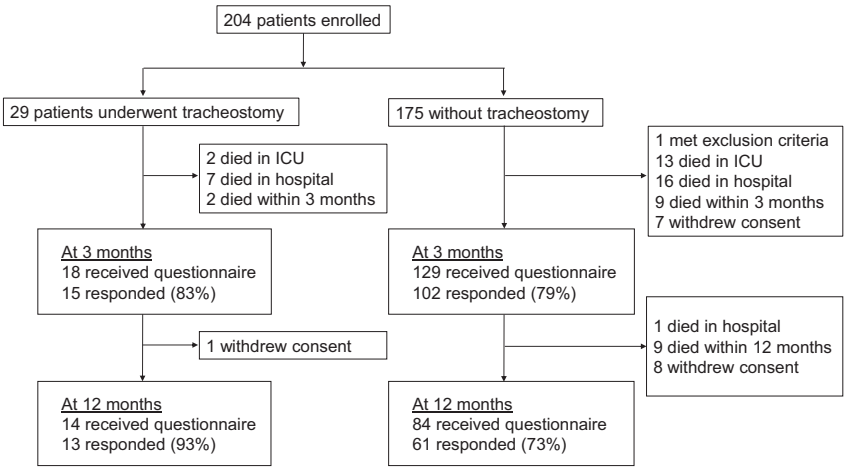

Fig. 1. Patient flowchart. ICU, intensive care unit.

and the percentage of men was 57% (67/117) overall. The tracheostomy group included significantly more patients with diseases thought to directly influence the brain function than the non-tracheostomy group (6/15 [40%] versus 11/102 [11%]; $P = 0.003$). The duration of mechanical ventilation in ICU in the tracheostomy group was longer than that in the non-tracheostomy group (11 [7–21] versus 3 [2–6]; $P = \leq 0.0001$, day), as was length of ICU stay (11 [9–21] versus 5 [3–7]; $P = \leq 0.0001$, day), and hospital stay (48 [35–60] versus 28 [16–42]; $P = 0.001$, day). The reasons for indication of tracheostomy were persistent unconsciousness (4/15 [26%]), airway-patency problems (4/15 [26%]), persistent respiratory failure (3/15 [20%]), management of respiratory secretions (2/15 [13%]), and others (2/15 [13%]). Three patients in the tracheostomy group met the Berlin criteria for acute respiratory distress syndrome (ARDS)[21] during their ICU stay. In addition, all patients in the tracheostomy group were weaned off ventilation at hospital discharge.

The primary outcome is shown in Figure 2. BI tended to be lower in the tracheostomy group than in the non-tracheostomy group at 3 months after ICU discharge, although without significant difference between them (65 [10–100] versus 95 [59–100]; $P = 0.28$, 7/15 [47%] versus 30/102 [30%] scored ≤60; $P = 0.23$) (Table 2). HAD-Anxiety, HAD-Depression, and IES-R were similar in both groups at 3 months and again at 12 months (Table 2 and Table 3). BI at 12 months tended to be lower in the tracheostomy group than in the non-tracheostomy group (93 [30–100] versus 100 [85–100]; $P = 0.12$, 4/13 [33%] versus 11/61 [19%] scored ≤60; $P = 0.28$; Table 3).

Figure 3 shows the change of each basic element of ADL from BI score from 3 to 12 months after ICU discharge in the tracheostomy group. BI score slightly improved in more than half of the items: feeding, grooming, dressing, toilet use, transfer (bed to chair and back), mobility (on level surface) from 3 to 12 months. BI score remained almost unchanged in the rest of the items.

DISCUSSION

WE EVALUATED THE prevalence of PICS among tracheostomized patients compared with non-tracheostomized patients at 3 and 12 months after ICU discharge. Although it should be noted that none of the patients in the tracheostomy group needed long-term ventilation and were weaned off ventilation at hospital discharge, tracheostomy was not significantly associated with the prevalence of psychiatric symptoms (HADS-anxiety, HADS-depression, and IES-R) at either 3 or 12 months after ICU discharge. BI tended to be low in tracheostomized patients compared with non-tracheostomized patients, although without significant difference.

Regarding long-term mental health problems in tracheostomized patients, some studies have shown high incidence of long-term depressive symptoms: 16%–32% at 12 months.[7,11] Our study also showed high prevalence of psychiatric symptoms, which were 45%, 36%, and 30% related to depression, anxiety, and PTSD, respectively. However, our study showed that non-tracheostomized patients also substantially have psychiatric symptoms; the prevalence of psychiatric symptoms might not differ between non-tracheostomized and tracheostomized patients. Blecha *et al.*[11] reported that tracheostomy was not significantly associated with mental QOL or psychiatric disorders (depression, anxiety, PTSD, and obsessive–compulsive

Table 1. Baseline demographics and clinical characteristics of patients responded to questionnaires at 3 months

	Tracheostomy group (n = 15)	Non-tracheostomy group (n = 102)	P value
Age, years, median (IQR)	70 (58–81)	71 (60–78)	0.79
Male, n (%)	9 (60)	58 (57)	0.82
APACHE II score at ICU admission, median (IQR)	19 (16–26)	20 (16–23)	0.6
Barthel index before acute illness, median (IQR)†	100 (55–100)	100 (80–100)	0.78
Admission route			
Emergency department, n (%)	9 (60)	69 (68)	0.12
Operating room, n (%)	4 (27)	31 (30)	
General wards, n (%)	2 (13)	2 (2)	
Reason of ICU admission			
Sepsis, n (%)	4 (27)	43 (42)	0.64
Trauma, n (%)	3 (20)	18 (18)	
Cardiovascular, n (%)	0 (0)	3 (3)	
Central nerve system, n (%)	1 (7)	4 (4)	
Others, n (%)	7 (47)	34 (33)	
Patients with disease that directly influence the brain function, n (%)‡	6 (40)	11 (11)	0.003
Patients with mental illness, n (%)§	1 (7)	13 (13)	0.5
Patients received mechanical ventilation during ICU stay, n (%)	15 (100)	88 (86)	0.13
Ventilator-days in ICU, day, median (IQR)	11 (7–21)	3 (2–6)	<0.0001
Length of ICU stay, day, median (IQR)	11 (9–21)	5 (3–7)	<0.0001
Length of hospital stay, day, median (IQR)	48 (35–60)	28 (16–42)	0.001
Patients not under mechanical ventilation at hospital discharge, n (%)	15 (100)		
Patients decannulated at hospital discharge, n (%)	8 (53)		

IQR, interquartile range; APACHE II score, Acute Physiology and Chronic Health Evaluation II score; ICU, intensive care unit.
†Barthel index was missing for 4 patients in the tracheostomy group, and 11 patients in the non-tracheostomy group.
‡Diseases that directly influence the brain function include cardiopulmonary arrest, traumatic brain injury, stroke, and acute poisoning.
§The definition of patients with mental illness was those who had been diagnosed and took the medication.

disorder) according to Patients Health Questionnaire-9 and the Post-Traumatic Stress Syndrome-14 in ARDS survivors 1 year after ICU discharge. Similar results were obtained in our study including patients without ARDS. Moreover, specific psychiatric symptoms were also evaluated, such as depression, anxiety, and PTSD, not mental health-related QOL, which had been evaluated by previous studies.[8,10,12] This should facilitate the understanding of the reasons for impaired mental health-related QOL in tracheostomized patients.

Long-term physical function has been reported to be limited over a year in tracheostomized patients.[6–8] In particular, patients with ARDS frequently require prolonged mechanical ventilation and tracheostomy. Previous studies that enrolled patients with ARDS showed that the severely impaired physical function persisted over several years, irrespective of requiring tracheostomy.[22,23] Conversely, in our study, ADL was partially independent in about 70% of the

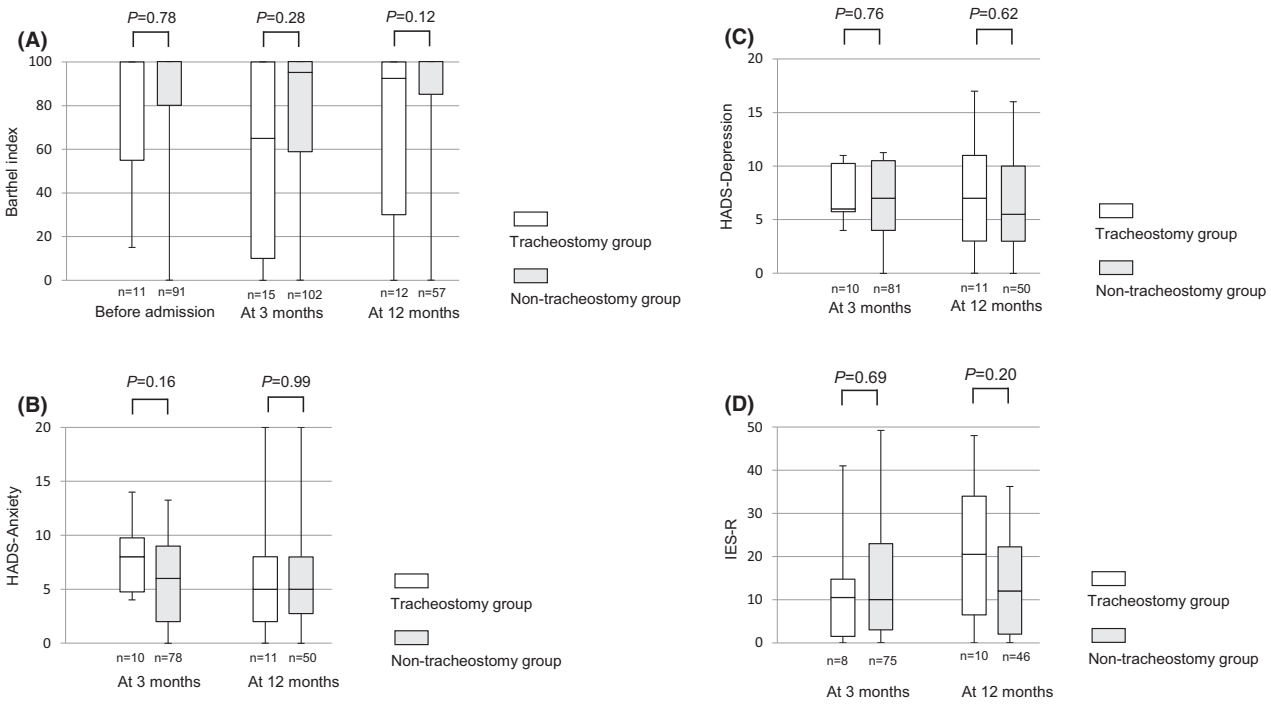

Fig. 2. Changes in activity of daily living and psychiatric symptoms of tracheostomy and non-tracheostomy group across follow-up. (A) Barthel index. (B) Hospital Anxiety and Depression Scale (HADS)-anxiety. (C) HADS-depression. (D) Impact of Event Scale-revised (IES-R).

tracheostomy group at 12 months (4/13 [33%], BI ≤60), although ADL was not independent in half of the tracheostomy group at 3 months (7/15 [47%], BI ≤60). This disparity might derive from the difference in reasons for tracheostomy. Our study included more patients without ARDS, such as those with airway-patency problems, rather than patients with ARDS (persistent respiratory failure). A previous study that included various patients without ARDS reported similar results.[12] In this study, Katz summary score (lower score indicates independence of ADL), which was 2.8 (95% confidence interval [CI], 2.3–3.3) before critical illness, worsened to 14.6 (95% CI, 13.9–15.2) at discharge, but it improved to 4.7 (95% CI, 3.8–5.6) at 12 months.[12] Physical summary score from a 36-item short-form health survey also improved to the level before critical illness at 12 months.[12] Accordingly, although long-term physical function after tracheostomy could be expected to improve over a year, the reasons for tracheostomy (e.g., ARDS) might substantially affect the trajectory of the long-term physical function. Moreover, the median age of our cohort was 71 years (60–78), which is older than that of previous studies (50s to early 60s).[7,8,10–12] Importantly, in this study, physical function showed the possibility of improvement over the course of a year, even in elderly patients. This study also included information about ADL elements that were causes of vulnerability of concern to patients and their families.

Recently, patients in ICU are aging, representative of the progression to an aging society seen in several developed countries.[24] Elderly critically ill patients are thought to be especially prone to have cognitive impairments, delirium, or severe conditions, all of which could impair their decision-making capacity.[25–26] Their family members, therefore, have to make such important decisions as surrogates. In a previous study, 70% of decisions were made by surrogates for hospitalized older adults.[13] Appropriate information on prognosis should not only consider survival, but also consider long-term functional outcomes. Our findings will inform the decision-making on tracheostomy in aging patients requiring critical care.

Our study has several limitations, the most critical being that this study was a subgroup analysis of a single center study. Multivariate models could not be constructed to adjust the differences in baseline characteristics because of the small numbers of outcome occurrences. We observed the difference that tracheostomized patients have more severe disease (i.e., longer duration of mechanical ventilation) and more instances of disease that could affect long term

Table 2. Comparison between tracheostomy and non-tracheostomy group at 3 months

	Tracheostomy group (n = 15)	Non-tracheostomy group (n = 102)	P value
Barthel index			
Data available, n (%)	15 (100)	102 (100)	
Score, median (IQR)	65 (10–100)	95 (59–100)	0.28
Score ≤60, median (%)	7 (47)	30 (30)	0.23
HADS-anxiety			
Data available, n (%)	10 (67)	78 (76)	
Score, median (IQR)	8 (5–10)	6 (2–9)	0.16
Score ≥8, n (%)	6 (60)	31 (40)	0.31
HADS-depression			
Data available, n (%)	10 (67)	81 (79)	
Score, median (IQR)	6 (6–10)	7 (4–11)	0.76
Score ≥8, n (%)	4 (40)	40 (49)	0.74
IES-R			
Data available, n (%)	8 (53)	75 (74)	
Score, median (IQR)	11(2–15)	10 (3–23)	0.69
Score ≥25, n (%)	1 (13)	16 (21)	1.0

HADS, Hospital Anxiety and Depression Scale; IES-R, Impact of Events Scale-Revised; IQR, interquartile range.

Table 3. Comparison between tracheostomy and non-tracheostomy group at 12 months

	Tracheostomy group (n = 13)	Non-tracheostomy group (n = 61)	P value
Barthel index			
Data available, n (%)	12 (92)	57 (93)	
Score, median (IQR)	93 (30–100)	100 (85–100)	0.12
Score ≤60, median (%)	4 (33)	11 (19)	0.28
HADS-anxiety			
Data available, n (%)	11 (85)	50 (82)	
Score, median (IQR)	5 (2–8)	5 (3–8)	0.99
Score ≥8, n (%)	4 (36)	16 (32)	1.0
HADS-depression			
Data available, n (%)	11 (85)	50 (82)	
Score, median (IQR)	7 (3–11)	6 (3–10)	0.62
Score ≥8, n (%)	5 (45)	19 (38)	0.74
IES-R			
Data available, n (%)	10 (77)	46 (75)	
Score, median (IQR)	21 (7–34)	12 (2–22)	0.20
Score ≥25, n (%)	3 (30)	9 (20)	0.43

HADS, Hospital Anxiety and Depression Scale; IES-R, Impact of Events Scale-revised; IQR, interquartile range.

sequelae (i.e., brain injury), which should worsen functional outcome at 3 months. Nevertheless, we could not observe any difference in functional outcomes at 3 months. This baseline difference might not weaken the importance of our results. However, the results have a wide range of 95% CI because of the small sample size, which may have missed clinically important differences. Therefore, our findings should, be interpreted as hypothesis-generating findings. Second, the indication for tracheostomy depends on the attending physicians. However, we decided to perform tracheostomy after sufficient discussion about the need for tracheostomy between physicians in a multidisciplinary team, the patients (when possible), and their families. Third, about

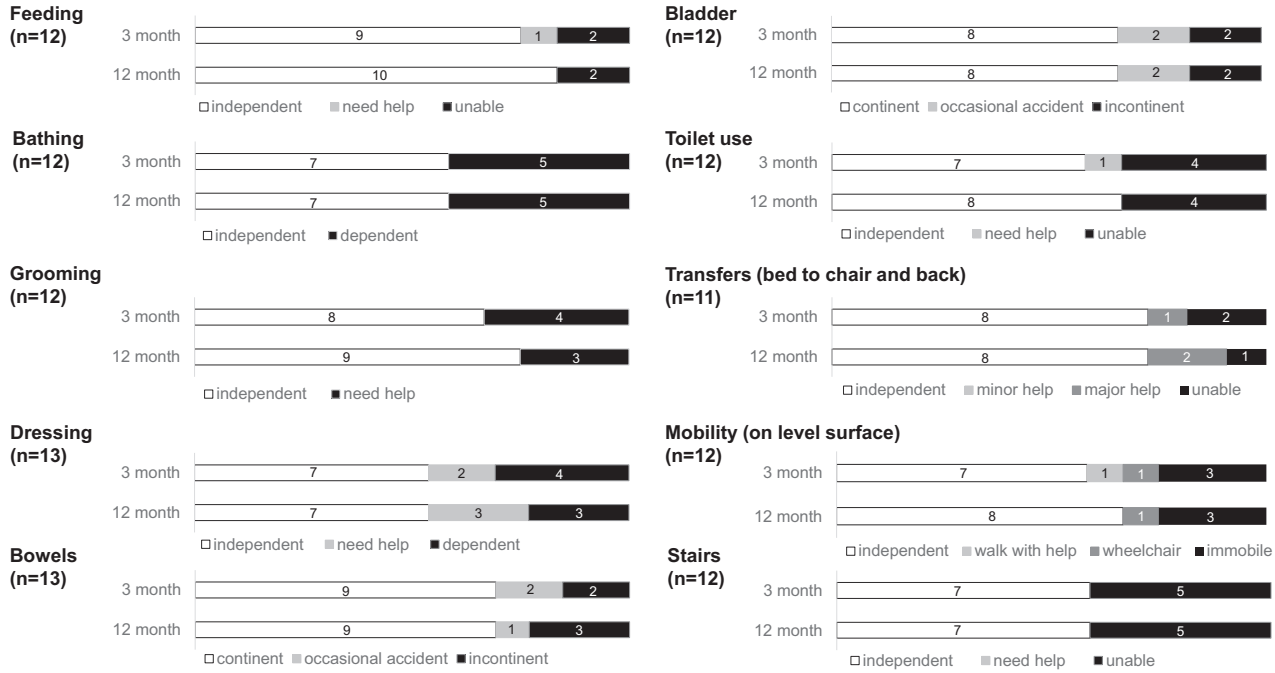

Fig. 3. Change of Barthel index. Change of each basic element of ADL from BI score from 3 to 12 months after ICU discharge in the tracheostomy group. ADL, activities of daily living; BI, Barthel index.

half of patients were able to have tubes removed and all patients were weaned off ventilation in the tracheostomy group. It is possible that the tracheostomy group in this study was less affected by tracheostomy, which might have influenced the results. However, even short-term tracheostomy may have a negative impact on long-term physical function or mental health, and future studies are needed to evaluate this. Further studies should aim to verify, which patient factors could predict good long-term physical/mental function among patients receiving tracheostomy, enabling better decision making on tracheostomy for patients and their families. Furthermore, there is a need for establishment of a network for large multicenter studies in Japan that can lead to subgroup analyses such as on ARDS or prolonged mechanical ventilation.

CONCLUSIONS

BI, HADS, AND IES-R were not significantly worse in patients that underwent tracheostomy at 3 and 12 months after ICU discharge compared with patients that did not. This study might inform the shared decision making with critically ill patients and their families about tracheostomy. The number of patients is, however, too small to be conclusive, and further larger studies are needed.

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DISCLOSURE

APPROVAL OF RESEARCH Protocol: The protocol for this research project has been approved by a suitably constituted institutional ethics committee (Wakayama Medical University, approval no. 1864). It conforms to the provisions of the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from all participants or legally authorized guardians before study enrollment.

Registry and the Registration No. of the study/Trial: The UMIN Clinical Trial Registry, UMIN000023743. Registered on September 1, 2016. (https://upload.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000027346)

Animal Studies: N/A

Conflict of Interest: None declared.

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