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Contents

Trends in tracheostomy use among critically-ill adult patients receiving anticipated prolonged invasive mechanical ventilation: a retrospective cohort study in a Canadian provincial regional catchment area from 2013 to 2019

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INTRODUCTION

Tracheostomy is commonly performed in critically-ill patients receiving anticipated prolonged invasive mechanical ventilation (IMV). Suggested benefits of IMV via a tracheostomy include decreased sedation requirements, improved pulmonary toilet, and accelerated ventilator weaning. Nevertheless, tracheostomy use among mechanically-ventilated patients may also be associated with poorer outcomes, including increased intensive care unit (ICU), in-hospital, and 28-day mortality, and impaired functionality among long-term ICU survivors. Clinicians must appropriately identify suitable candidates who may benefit from this procedure while considering risk factor profiles, prognosis, and patient goals of care. The overall objective of this study is to examine trends in tracheostomy use, timing, and outcomes for anticipated prolonged IMV, and to determine baseline patient and ICU admission characteristics associated with tracheostomy receipt compared with ongoing translaryngeal intubation (TLI). The results of this descriptive epidemiological analysis may help inform clinicians, patients, and their families to assist in their decision-making process regarding management strategies in this critically-ill population.

METHODS

This retrospective cohort study examines critically-ill adults (≥ 18 yr) requiring admission to a level-3 ICU in the regional catchment area of a Canadian provincial health authority between 1 January 2013 and 31 December 2019 (inclusive) with respiratory failure (RF) requiring IMV for at least three consecutive days. Clinical and health administrative data, obtained from a prospectively-maintained centralized regional critical care database, include sociodemographic characteristics, APACHE II severity of illness scores, lengths of stay (LOS), ICU organ support and related procedures, and ICU mortality. The primary outcome is ICU mortality, with ventilator-

free days (VFDs), IMV duration, ventilator-associated pneumonia (VAP), and ICU LOS as secondary outcomes. Age- and sex-standardized use rates per 1,000 ventilated adult residents were determined as: 1) cumulative incidence rates of *de novo* tracheostomy insertion among adult hospitalized patients receiving IMV to estimate overall population burden; and 2) average (age-adjusted) annual percent change (AAPC) in the incidence rate of tracheostomy. Generalized linear models were used to examine trends in patient and hospital characteristics associated with tracheostomy receipt, timing, and use over the study period.

RESULTS

Between 1 January 2013 to 31 December 2019, there were 7,455 eligible IMV episodes among 7,192 adults admitted to a level-3 ICU in the Canadian province under study, of whom 439 underwent tracheostomy whereas 6,753 received ongoing TLI during their first qualifying (index) IMV episode. The AAPC in the tracheostomy incidence rate was −3.2% (95% confidence interval [CI], −12.0 to 7.3) overall, and −4.5 (−11.6 to 4.2) and 0.2 (−22.8 to 29.8) among males and females, respectively. The modeled age-adjusted rate per 1,000 ventilated patients decreased from 78.5 in 2013 to 64.4 in 2019, although this decrease was not statistically significant. Regarding trends among APACHE II principal admission diagnosis category groups, the AAPC was −1.9 (−26.5 to 49.0), −3.9 (−10.2 to 2.4), 11.2 (−3.9 to 26.5), and −14.8 (−31.7 to 6.7) for cardiovascular, neurologic, respiratory, and other conditions, respectively (see Table 1 for additional results).

DISCUSSION

This study provides potentially informative population-level data on trends in tracheostomy use, associated characteristics, and patient outcomes from a large province-wide, Canadian perspective with robust data sources. These results will be useful in apprising health care providers of variables potentially associated with post-tracheostomy outcomes in prolonged IMV settings to facilitate the development and adoption of more patient-centered management strategies. Canada's aging population will increasingly challenge our health care systems, and informing patients and their families of anticipated outcomes following tracheostomy in a diverse critically-ill patient population may aid with appropriate decision-making and resource use.

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Table 1 Tracheostomy use, patient characteristics, and outcomes among adults receiving invasive mechanical ventilation in a Canadian provincial regional catchment area, 2013–2019, overall and by year

Characteristic		2013 (N=1071)	2014 (N=1003)	2015 (N=1012)	2016 (N=951)	2017 (N=1034)	2018 (N=1032)	2019 (N=1089)	Total (N=7192)	P-Value
Tracheostomy receipt, N (%)		61 (5.7%)	46 (4.6%)	54 (5.3%)	80 (8.4%)	61 (5.9%)	71 (6.9%)	66 (6.1%)	439 (6.1%)	0.017
Tracheostomy timing (days), median (IQR)		15 (11, 19)	20 (14, 26)	15.5 (11, 22)	16 (10, 22)	15 (12, 20)	16 (11, 23)	18.5 (14, 23)	16 (11, 22)	0.038
Age group (years), N (%)	Age 18-59	436 (40.7%)	457 (45.6%)	430 (42.5%)	426 (44.8%)	452 (43.7%)	418 (40.5%)	462 (42.4%)	3081 (42.8%)	0.019
	Age 60-79	496 (46.3%)	453 (45.2%)	471 (46.5%)	451 (47.4%)	484 (46.8%)	510 (49.4%)	525 (48.2%)	3390 (47.1%)	
	Age 80+	139 (13.0%)	93 (9.3%)	111 (11.0%)	74 (7.8%)	98 (9.5%)	104 (10.1%)	102 (9.4%)	721 (10.0%)	
Age (years), median (IQR)		64 (51, 73)	61 (50, 72)	63 (51, 73)	62 (48, 71)	63 (49, 72)	63 (52, 72)	62 (50, 71)	63 (50, 72)	0.02
Female sex, N (%)		429 (40.1%)	415 (41.4%)	412 (40.7%)	393 (41.3%)	435 (42.1%)	412 (39.9%)	443 (40.7%)	2939 (40.9%)	0.959
Hospital type, N (%)	Community	316 (29.5%)	278 (27.7%)	291 (28.8%)	291 (30.6%)	284 (27.5%)	250 (24.2%)	200 (18.4%)	1910 (26.6%)	<.001
	Tertiary	755 (70.5%)	725 (72.3%)	721 (71.2%)	660 (69.4%)	750 (72.5%)	782 (75.8%)	889 (81.6%)	5282 (73.4%)	
ICU type, N (%)	Coronary care	117 (10.9%)	95 (9.5%)	76 (7.5%)	90 (9.5%)	115 (11.1%)	137 (13.3%)	153 (14.0%)	783 (10.9%)	<.001
	Medical	241 (22.5%)	249 (24.8%)	237 (23.4%)	208 (21.9%)	228 (22.1%)	240 (23.3%)	281 (25.8%)	1684 (23.4%)	
	Medical-surgical	510 (47.6%)	467 (46.6%)	490 (48.4%)	456 (47.9%)	462 (44.7%)	452 (43.8%)	437 (40.1%)	3274 (45.5%)	
	Surgical	203 (19.0%)	192 (19.1%)	209 (20.7%)	197 (20.7%)	229 (22.1%)	203 (19.7%)	218 (20.0%)	1451 (20.2%)	
Admission source, N (%)	ER/UC	529 (49.4%)	511 (50.9%)	495 (48.9%)	509 (53.5%)	505 (48.8%)	542 (52.5%)	524 (48.1%)	3615 (50.3%)	<.001
	ICU	20 (1.9%)	33 (3.3%)	29 (2.9%)	23 (2.4%)	34 (3.3%)	15 (1.5%)	15 (1.4%)	169 (2.3%)	
	OR/RR	212 (19.8%)	181 (18.0%)	183 (18.1%)	174 (18.3%)	216 (20.9%)	208 (20.2%)	244 (22.4%)	1418 (19.7%)	
	Ward	301 (28.1%)	270 (26.9%)	289 (28.6%)	241 (25.3%)	278 (26.9%)	266 (25.8%)	304 (27.9%)	1949 (27.1%)	
	Other	9 (0.8%)	8 (0.8%)	16 (1.6%)	4 (0.4%)	1 (0.1%)	1 (0.1%)	2 (0.2%)	41 (0.6%)	
APACHE II total score, median (IQR)		21 (17, 27)	21 (17, 27)	23 (17, 28)	21 (17, 27)	22 (18, 28)	23 (18, 29)	23 (18, 29)	22 (17, 28)	—
Admission type (for APACHE II), N (%)	Medical	836 (78.1%)	804 (80.2%)	791 (78.2%)	725 (76.2%)	757 (73.2%)	793 (76.8%)	840 (77.1%)	5546 (77.1%)	<.001
	Elective surgery	124 (11.6%)	87 (8.7%)	80 (7.9%)	70 (7.4%)	62 (6.0%)	91 (8.8%)	89 (8.2%)	603 (8.4%)	
	Emergency surgery	111 (10.4%)	112 (11.2%)	141 (13.9%)	156 (16.4%)	215 (20.8%)	148 (14.3%)	160 (14.7%)	1043 (14.5%)	
Admission type (for APACHE II) = Surgical, N (%)		235 (21.9%)	199 (19.8%)	221 (21.8%)	226 (23.8%)	277 (26.8%)	239 (23.2%)	249 (22.9%)	1646 (22.9%)	0.015
Admission type (for APACHE II) = Surgical Emergency, N (%)		111 (10.4%)	112 (11.2%)	141 (13.9%)	156 (16.4%)	215 (20.8%)	148 (14.3%)	160 (14.7%)	1043 (14.5%)	<.001
Principal admission diagnosis category group, N (%)	Cardiovascular	545 (50.9%)	493 (49.2%)	544 (53.8%)	526 (55.3%)	619 (59.9%)	621 (60.2%)	623 (57.2%)	3971 (55.2%)	<.001
	Neurologic	101 (9.4%)	131 (13.1%)	126 (12.5%)	106 (11.1%)	142 (13.7%)	121 (11.7%)	135 (12.4%)	862 (12.0%)	
	Respiratory	295 (27.5%)	276 (27.5%)	224 (22.1%)	217 (22.8%)	164 (15.9%)	191 (18.5%)	241 (22.1%)	1608 (22.4%)	
	Other	130 (12.1%)	103 (10.3%)	118 (11.7%)	102 (10.7%)	109 (10.5%)	99 (9.6%)	90 (8.3%)	751 (10.4%)	
APACHE II predicted risk of (in-hospital) mortality (%), median (IQR)		41 (19, 61)	41 (20, 60)	44 (21, 66)	41 (20, 63)	46 (24, 66)	48 (27, 70)	51 (28, 73)	45 (23, 66)	<.001
Charlson Comorbidity Index score, median (IQR)		2 (1, 4)	2 (1, 4)	2 (1, 4)	2 (1, 4)	2 (1, 4)	2 (1, 4)	2 (1, 4)	2 (1, 4)	—
ICU LOS (days), median (IQR)		8 (5, 13)	8 (5, 13)	8 (5, 13)	8 (5, 14)	7 (4, 13)	8 (4, 14)	7 (4, 13)	8 (4, 13)	0.045
IMV duration (days), median (IQR)		6 (4, 10)	6 (4, 10)	6 (4, 10)	6 (4, 11)	6 (4, 10)	6 (4, 11)	6 (4, 11)	6 (4, 10)	0.002
ICU mortality (overall), N (%)		224 (20.9%)	207 (20.6%)	220 (21.7%)	135 (14.2%)	241 (23.3%)	257 (24.9%)	271 (24.9%)	1555 (21.6%)	<.001
ICU mortality (28-day), N (%)		253 (23.6%)	216 (21.5%)	230 (22.7%)	140 (14.7%)	245 (23.7%)	268 (26.0%)	294 (27.0%)	1646 (22.9%)	<.001
Ventilator-free days (VFD) to day 28, median (IQR)		20 (0, 23)	20 (2, 23)	20 (0, 23)	19 (9, 23)	19 (0, 23)	18 (0, 23)	18 (0, 23)	19 (0, 23)	—
Ventilator-associated pneumonia (VAP), N (%)		45 (4.2%)	43 (4.3%)	38 (3.8%)	45 (4.7%)	52 (5.0%)	55 (5.3%)	68 (6.2%)	346 (4.8%)	0.145

APACHE II, Acute Physiology and Chronic Health Evaluation II; ER, emergency room; ICU, intensive care unit; IMV, invasive mechanical ventilation; LOS, length of stay; OR, operating room; RR, recovery room; TLI, translaryngeal intubation; UC, urgent care; VAP, ventilator-acquired pneumonia; VFD, ventilator-free days.