Smoking cessation therapy in Australian and New Zealand intensive care units: a multicentre point prevalence study

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ABSTRACT

Objective: To obtain an accurate estimate of smoking prevalence and smoking cessation support practices, including nicotine replacement therapy (NRT), in Australian and New Zealand intensive care units (ICUs).

Design, setting and participants: Cross-sectional, observational study using data obtained from adult ICUs participating in the Australian and New Zealand Intensive Care Society Clinical Trials Group Point Prevalence Program in 2016.

Main outcome measures: Prevalence and intensity of current smoking, baseline characteristics of smokers in comparison with non-smokers and frequency of NRT use while admitted to the ICU.

Results: Smoking data were present for 551 of 671 adult ICU patients from 47 ICUs on 2 study days in 2016. Of these 551 patients, 112 were current smokers (20.3%; 95% CI, 17.0–23.9%). No significant differences in severity of illness or mortality were observed between smokers and non-smokers. NRT was prescribed to 30/112 smokers (26.8%), and in 28 of those 30 patients (93%) it was administered via nicotine patch alone. Routine prescribing of NRT was practised in 28/47 ICUs (60%), and 24/47 ICUs (51%) had formal protocols or guidelines in place related to supporting smoking cessation.

Conclusions: The prevalence of smoking in Australian and New Zealand ICUs patients is high. Over half of participating ICUs reported the routine prescription of NRT despite uncertainty regarding the practice. Further research evaluating the safety and efficacy of NRT is required.

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Delirium acquired in the intensive care unit (ICU) is associated with morbidity and mortality, and measures to reduce it may improve patient outcomes.[1-3] In critically ill patients, active smoking is associated with delirium in the ICU,[4,5] with nicotine withdrawal potentially contributing to this delirium.[6] In case series, nicotine replacement therapy (NRT) has been reported to improve delirium associated with presumed nicotine withdrawal;[7] however, recent systematic reviews report a lack of evidence regarding the safety and efficacy of NRT use in the ICU.[8,9] Retrospective[10,11] and prospective[12] cohort studies have reported increased incidence of delirium in ICU patients receiving NRT, and an increased need for antipsychotic medications, physical restraint and longer duration of intubation.[13] The effect of NRT on mortality is uncertain, with retrospective studies variously reporting increased,[14,15] decreased[10] and comparable[11] rates of death among smokers receiving NRT in the ICU compared with those not receiving NRT. Only a small pilot randomised controlled trial of NRT, with 40 participants, has been performed in the ICU, and it showed a reduced ICU length of stay and ventilator bed-days with NRT compared with controls, although the results were not statistically significant.[16] Therefore, the safety and efficacy of NRT in critically ill patients remains an open question.

To address these concerns, our group has commenced a research program evaluating the safety and efficacy of NRT use in critically ill adults. The Australian and New Zealand Intensive Care Society Clinical Trials Group (ANZICS CTG) Point Prevalence Program (PPP) is an annual, multicentre, single-day point prevalence study of patients admitted to the ICU at participating sites in Australia and New Zealand.[17] Previous PPP investigations have included themes as diverse as ICU venous thromboembolism prophylaxis,[18] and fluid and sodium administration.[19,20] To guide future research, we used the 2016 PPP to determine the prevalence of NRT use in critically ill patients admitted to Australian and New Zealand ICUs.

Methods

We performed a prospective cross-sectional point prevalence study at Australian and New Zealand adult ICUs, as part of the PPP (a collaboration between the ANZICS CTG and the George Institute for Global Health), on 23 August and 7 September 2017, using the methods previously described.[17] The ICU data were collected over 2 study days — on either the first or the second day of data collection. Ethics approval with a waiver of consent was obtained at each site participating in the PPP (online Appendix available at cicm.org.au/Resources/Publications/Journal).

In addition to the standard PPP patient demographic and admission data, specific questions relating to the patient's

smoking history and NRT administration were embedded within the case report form. These data included current smoking status, an estimate of cigarette consumption (ie, cigarettes per day, packs per week or pack-years, as recorded in the patient notes), and NRT prescription and type. Packs per week were converted to cigarettes per day using an assumed pack size of 25 cigarettes per pack, based on 2013 Australian cigarette sales data (pack size, 20–24 cigarettes [proportion of sales, 12% of sales of all cigarette packs]; 25–30 cigarette packs [36%]; 30–39 cigarette packs [18%]; 40 cigarette packs [22%]; 50 cigarette packs [10%]).[21] The patient's admission was separately classified as smoking-related or not, based on the treating ICU consultant or registrar's opinion and on the APACHE (Acute Physiology and Chronic Health Evaluation) III diagnosis codes (Table 1). ICU and hospital discharge and vital status were assessed 28 days after the study date. For all sites, unit-level questions were asked about existing smoking cessation protocols or guidelines for supporting ICU patients who smoke. The research coordinators entered the patient data via an online case report form using REDcap (Research Electronic Data Capture).[23] Patients were compared based on whether they were current smokers versus non-current smokers, those with missing smoking data were excluded from such analysis.

The statistical analysis was performed using Stata 14.1 (StataCorp, Texas, USA). Categorical data were summarised using number (%), and proportions were compared using the Fisher exact test; continuous data were summarised as mean (standard deviation) and compared with the Student *t* test, or summarised as median (interquartile range [IQR]) and compared with Mann–Whitney (Wilcoxon rank sum) test. When relevant, 95% confidence intervals (CIs) for the difference in proportions and means were calculated.

Table 1. Smoking-related APACHE III diagnoses[22]

Non-operative	Operative
Cardiac arrest*	Peripheral vascular disease
Aortic aneurysm*	Peripheral artery bypass graft
Peripheral vascular disease	Elective abdominal aortic aneurysm*
Acute myocardial infarction*	Carotid endarterectomy*
Unstable angina	CABGs*
Respiratory neoplasm, including larynx/trachea	Dissecting aortic aneurysm*
Respiratory arrest*	Ruptured aortic aneurysm*
Chronic obstructive pulmonary disease*	Aorto-femoral bypass graft
Asthma*	CABG with valve*
Bacterial pneumonia*	Endoluminal aortic repair*
Viral pneumonia*	Respiratory neoplasm (lung)
Stroke*	Respiratory neoplasm (mouth, larynx, sinus, trachea)*

APACHE = Acute Physiology and Chronic Health Evaluation.
CABG = coronary artery bypass graft. * Diagnosis present on study day.

Results

Data on 671 patients (median, 12 patients per ICU; IQR, 7–17) were available from 47 Australian and New Zealand ICUs that participated in the PPP. Smoking-related data were available for 551/671 patients (82%) (Table 2). Figure 1 indicates the patient smoking status along with missing data, by unit, in the 47 studied adult ICUs in Australia and New Zealand. Of the 551 patients, 112 were current smokers (20.3%; 95% CI for population proportion, 17.0–23.9%). The smoking prevalence at each unit on the day of the study ranged from 0% to 63% (median, 20%; IQR, 8–35%). Compared with non-smokers, smokers were younger (mean difference, –9.9 years; 95% CI, –13.3 to –6.5 years; $P < 0.001$) and less likely to have been admitted to the ICU with an operative diagnosis (29/112, 25.9% *v* 181/439, 41.2%; RR, 0.63; 95% CI, 0.45–0.88; $P = 0.003$). Overall, 30/112 active smokers (26.8%) were prescribed NRT, and in 28 of these 30 patients (93%), NRT was administered via a nicotine patch (Figure 2). Of the 47 participating ICUs, 28 (60%) reported that the prescription of NRT to smokers during their ICU admission was routine practice, and 24/47 units (51%) reported that they had a smoking cessation and nicotine dependence guideline or protocol (Figure 3). In ICUs with routine interventions or protocols, 23/77 of patients (30%) who smoked were prescribed NRT compared with seven out of 35 patients (20%) at units without these protocols (95% CI, 0.71–3.15; $P = 0.36$). The smoking prevalence was similar at ICUs with and without smoking cessation intervention or protocols (77/365, 21% *v* 35/186, 19%; 95% CI, 0.78–1.6; $P = 0.58$). We did not find that a greater prevalence of smoking among ICU patients equated to a higher likelihood of ICU smoking cessation protocols. These interventions are listed in Table 3 and Figure 3.

There were no significant differences in ICU or hospital mortality at 28 days between smokers and non-smokers. For smokers with cigarette consumption recorded as cigarettes per day or packs per week ($n = 66$), the median cigarette consumption was 11 cigarettes per day (IQR, 6–60). Where cigarette consumption was recorded in pack-years ($n = 13$), the median smoking history was 40 pack-years (IQR, 30–50). Smoking intensity data were missing for 34 patients (30%). Thirty-seven out of 112 patients' admissions (33%) were thought to be related to smoking, in the opinion of the ICU consultant or registrar, although there was no documentation for 20/112 patients (18%). By the APACHE III diagnosis code, 45/112 patients (40%) had a diagnosis that could reasonably be expected to be related to their smoking status (Table 1 and Table 2). In 74% of cases, the assessments by both methods were concordant.

Table 2. Patient information: smoking data, reasons for intensive care unit (ICU) admission, and types and frequencies of nicotine replacement therapy (NRT)

Variable	Smoker	Non-current smoker	MD/RR	95% CI	*P*
Number of patients*	112 (20.3%)			17.0–23.9%	
Age (years); mean (SD)	53.0 (15.0)	62.9 (16.8)	MD –9.9	–13.3 to –6.5	<0.001
Female	45 (40.2%)	186 (42.4%)			0.74
Smoking intensity					
Not stated	34 (30.0%)				
Cigarettes/day, median (IQR)†	11 (6–60)				
Pack-years, median (IQR)	40 (30–50)				
Nature of illness					
APACHE III score; mean (SD)	18.4 (8.3)	17.7 (8.2)	MD 0.7	–2.4 to 1.0	0.44
Post-operative	29 (25.9%)	181 (41.2%)	RR 0.63	0.45–0.88	0.003
Cardiac arrest	2 (1.8%)	20 (4.6%)			0.28
Respiratory arrest	9 (8.0%)	28 (6.4%)			0.53
Smoking-related admission					
Reported	37 (33.0%) [ND, 20 (17.9%)]			24.4–42.6%	
APACHE III diagnosis‡	45 (40.2%)			31.0–49.9%	
Both reported and APACHE III diagnosis	26 (23.2%)		RR 3.2	1.8–5.7	<0.001
ICU mortality at 28 days	11 (9.8%)	39 (8.8%)	RR 1.1	0.59–2.1	0.72
Hospital mortality at 28 days	17 (15.2%)	57 (13.0%)	RR 1.2	0.71–1.9	0.54
ICU therapy					
Prescribed NRT	30 (26.8%)				
Patch	28 (25.0%)				
Gum	1 (0.9%)				
Tablets	0 (0.0%)				
Inhalers	0 (0.0%)				
Other	2 (1.8%)				

APACHE = Acute Physiology and Chronic Health Evaluation. CI = confidence interval. IQR = interquartile range. MD = mean difference. ND = not documented. RR = relative risk. SD = standard deviation. * Excludes patients with missing smoking data. † Where reported in packs per day, a pack size of 25 cigarettes was assumed. ‡ Box 1.

Discussion

Main findings and comparison to prior literature

To our knowledge, this is the first multicentre cohort study to describe the prevalence of NRT in intensive care. Two-thirds of units reported standardised prescribing of NRT, with about a quarter of smokers being prescribed NRT on the study day. We found that 20% of patients were active smokers, smoking just over ten cigarettes per day, with a median of 40 pack-years of smoking. This estimate of the overall proportion of smokers in Australian and New Zealand ICUs was similar to previous ICU retrospective cohort studies done in this region[13,24] and higher than in the general population in both Australia (16%) and New Zealand (16%).[25,26] Smokers admitted to ICU were younger and less likely to have been admitted after and operation. In some cases, there was limited awareness of a patient's smoking history — almost 20% of patients were missing smoking data, and 30% of patients with known smoking status lacked an estimate of intensity of current use. Clinicians thought that the ICU admission was related to their patient's smoking in one-third of cases, and when APACHE diagnoses were examined, smoking may have been a relevant factor in up to 40% of patients.

Clinical implications

The smoking rate of patients in Australian and New Zealand ICUs is similar to other hospital groups (23% in Australian emergency department patients),[27] and considerably higher than in the general Australian[25] and New Zealand[26] communities. Our results show the widespread use of NRT in Australian and New Zealand ICUs. Such use occurs despite limited efficacy data and associations with increased morbidity and mortality,[11-15] or reduced or no effect on morbidity and mortality.[10,11] The use of NRT in the community is based on evidence from systematic reviews and is widely accepted practice.[28] Nicotine is a potent cholinomimetic that acts primarily on the nicotinic acetylcholine receptor.[29] In the brain, nicotine has multiple effects,

Figure 1. Patient smoking status, by unit, in 47 adult intensive care units in Australia and New Zealand

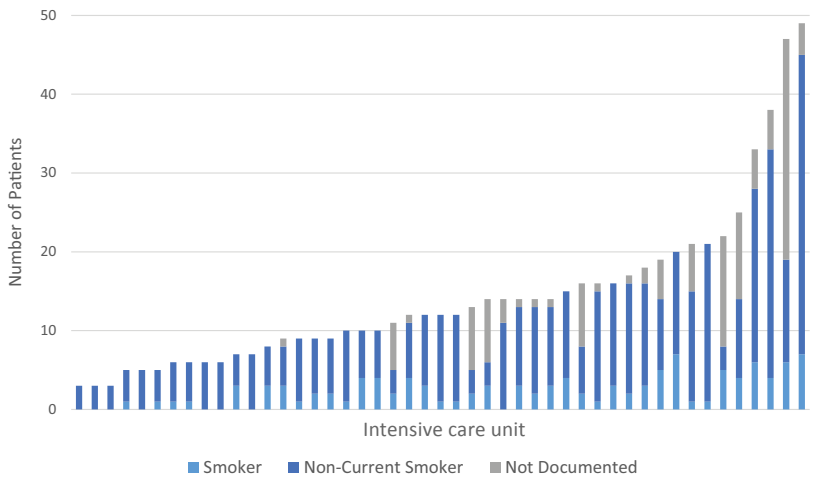


Figure 2. Proportion of smokers prescribed nicotine replacement therapy

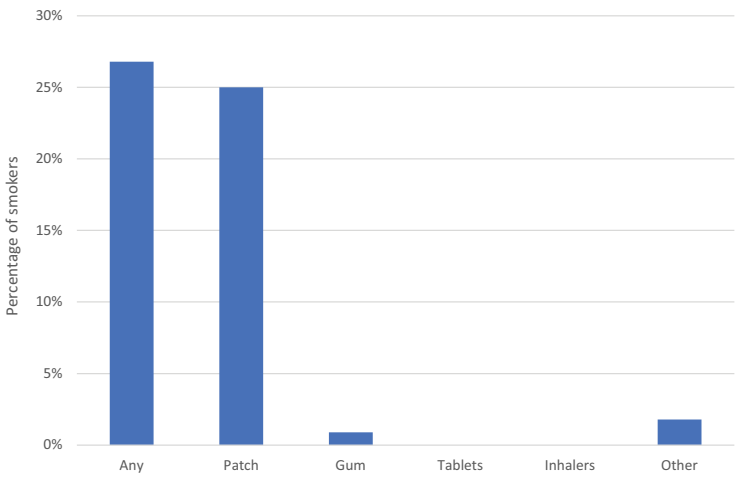
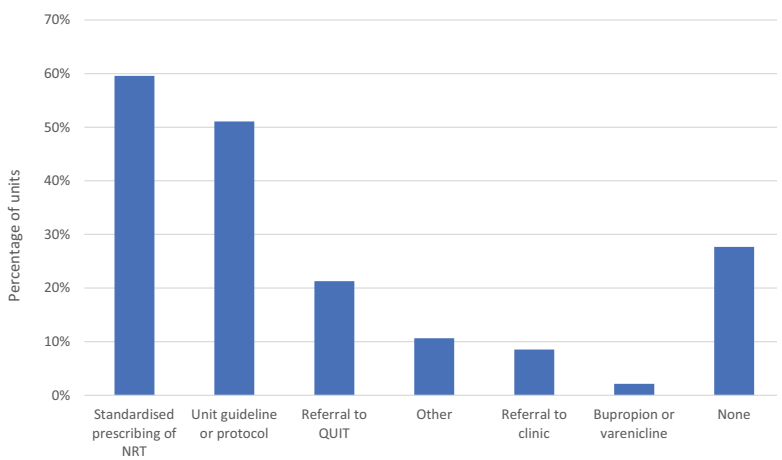


Figure 3. Intensive care unit (ICU) smoking cessation interventions at participating ICUs



NRT = nicotine replacement therapy.

Table 3. Unit interventions to support smoking cessation in 47 adult intensive care units in Australia and New Zealand

Intervention	Prevalence *n* = 47
Unit guideline or protocol	24 (51%)
Routine prescribing of NRT	28 (60%)
Referral to QUIT	10 (21%)
Referral to addiction medicine or cessation clinic	4 (9%)
Prescription of bupropion or varenicline	1 (2%)
Other	5 (11%)
None	13 (28%)
Number of interventions per unit, median (IQR)	2 (0–2)

IQR = interquartile range. NRT = nicotine replacement therapy.

causing the release of dopamine while stimulating the sympathetic nervous system of the medulla oblongata leading to tachycardia, vasoconstriction, hypertension and tachypnoea. Toxic neurological sequelae of nicotine include central nervous system stimulation and delirium. It is therefore biologically plausible that the administration of nicotine to critically ill patients could have adverse effects.

Our results also highlight the ongoing high prevalence of smokers among the Australian and New Zealand ICU population and the need for increased awareness of these patients' smoking status, intensity and relationship to current illness. Importantly, we found that referral to addiction support services does not occur routinely in the majority of units. While this type of referral may be seen as being beyond the domain of an ICU, there is good evidence that many smokers do consider quitting after an ICU admission,[30] and since clinicians have a shared responsibility to encourage smoking cessation, they should seek to better leverage this potentially "teachable moment".[31]

Strengths and limitations

This single day multicentre, point prevalence study provides a useful estimate of the prevalence of smoking among a broad range of Australian and New Zealand ICUs, extending existing local literature, which has so far focused on single unit estimates or smaller groups of units. Moreover, the study provides an insight into the current range of smoking cessation practices to support smokers in the ICU.

A number of factors limit the generalisability of our results. First, the total number of patients in the sample was limited by the single-day inclusion period, yielding only 112 smokers. Second, although 47 units participated in the 2016 PPP, making this the largest observational study of smoking and NRT in the ICU with regard to site participation, it represents only 23% of the 206 adult Australian and New Zealand ICUs.[32] Patients were classified as either current smokers or non-current smokers, and smoking-related data were not collected from ex-smokers. The smoking-related data were absent in about 20% of patients; therefore, our estimate of the prevalence of NRT and smoking may underestimate the true value. An estimate of smoking intensity was missing in almost one-third of patients, and data on duration of smoking were not collected, other than an estimate of pack-years. Estimates of the relationship between a patient's smoking and reason for admission to the ICU may also underestimate the true value, as the question was not answered by clinicians in 20% of cases. The extrapolation of Australian pack size to New Zealand ICU patients is a potential source of error. New Zealand ICU beds represent 12% of the ANZICS Centre for Outcome and Resource Evaluation dataset.[32] In this study, 21% of the participating ICUs are from New Zealand; however, the rates of smoking in Australia (16%)[25] and New Zealand (16%)[26] are similar.

We did not collect the dose of NRT provided, but the Royal Australian College of General Practitioners nicotine replacement guidelines indicate that: "Smokers of 10 or more cigarettes per day should start with a full strength patch (21 mg/24 hours or 15 mg/16 hours)".[28,33] In addition, the prevalence of smoking may be higher in some cultural groups and the ethnicity of patients in this cohort is not available. Finally, the 2016 PPP did not include longitudinal measures of other potential variables of interest when evaluating smokers in ICU, such as incidence or duration of mechanical ventilation, delirium or agitation over the ICU admission, timing of NRT commencement and any association with the onset of symptoms of withdrawal or delirium.

Conclusion

Smoking remains common in Australian and New Zealand ICUs, with NRT forming the mainstay of cessation support for smokers admitted to the ICU. Yet, we do not know if NRT is beneficial for patients, and if so, when it should be commenced during an ICU stay. There is a need for further research in this area, particularly on NRT use while admitted to the ICU and on longer term support for smoking cessation after ICU admission. These findings provide a valuable baseline from which to plan future studies.

Acknowledgement

The list of participating sites, principal investigators and research coordinators for the 2016 Point Prevalence Program is included in the online Appendix.

Competing interests

None declared.

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Appendix

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Appendix 1 – List of participating sites and investigators

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John Hunter Hospital, Newcastle, NSW	Miranda Hardie
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North Shore Private Hospital, Sydney, NSW	Anthony Delaney, Dena-Louise Hogben, Joanna Hallam, Rosalind Elliot
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Royal Prince Alfred Hospital, Sydney, NSW	David Gattas, Heidi Buhr, Debra Hutch
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New Zealand	
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Waikato Hospital, Hamilton, New Zealand	Annette Forrest, Jewel Barlow-Armstrong, Kara Trask
Wellington Hospital, Wellington, New Zealand	Dick Dinsdale, Anna Hunt, Leanlove Navarra, Raulle Cruz
North Shore Hospital, Auckland, New Zealand	Janet Liang, Danni Hacking
Tauranga Hospital, Tauranga, New Zealand	Troy Browne, Jennifer Goodson
Nelson Hospital, Nelson, New Zealand	Bruce King, Jill Norton, Robyn Price, Joy Tomlinson
Princess Alexandra Hospital, Brisbane, QLD	Chris Joyce, Jason Meyer, Emma Saylor, Ellen Venz
Mackay Base Hospital, Mackay, QLD	Stuart Baker
Nambour General Hospital, Nambour, QLD	Peter Garrett, Loretta Forbes
Flinders Medical Centre, Adelaide, SA	Santosh Verghese, Elisha Matheson, Kate Schwartz, Kate Norman
Lyell McEwin Hospital, Adelaide, SA	Peter Thomas, Natalie Soar
The Queen Elizabeth Hospital, Adelaide, SA	Sandra Peake, Tricia Williams, Cathy Kurenda
Royal Adelaide Hospital, Adelaide, SA	Stephanie O'Connor, Justine Rivett, Alex Poole, Sarah Doherty, Kathleen Glasby
Austin Hospital, Melbourne, VIC	Rinaldo Bellomo, Glenn Eastwood, Leah Peck, Helen Young
Bendigo Hospital, Bendigo, VIC	Jason Fletcher, Julie Smith
Cabrini Hospital, Melbourne, VIC	Vineet Sarode, Shannon Simpson
University Hospital Geelong, Geelong, VIC	Neil Orford, Allison Bone, Tania Elderkin
St Vincent’s Hospital, Melbourne, VIC	John Santamaria, Jennifer Holmes, Roger Smith
Footscray Hospital (Western Health), Melbourne, VIC	Craig French, Samantha Bates, Anna Tippett
Sunshine Hospital (Western Health), Melbourne, VIC	Craig French, Samantha Bates, Anna Tippett
Epworth Richmond, Melbourne, VIC	Jonathan Barrett, Gabrielle Hanlon
Epworth Freemasons, Melbourne, VIC	Graeme Webster, Sam Healey
Epworth Eastern, Melbourne, VIC	Stephen Warrillow, Zia Ansari, Sanjee de Silva
Royal Perth Hospital, Perth, WA	Geoff Dobb, Steve Webb, Lizzie Jenkinson
Sir Charles Gairdner Hospital, Perth, WA	Bradley Wibrow, Dr Matt Anstey, Brigit Roberts
St John of God Murdoch Hospital, Perth, WA	Adrian Regli, Anna Palermo
St John of God Subiaco Hospital, Perth, WA	Ed Litton, Janet Ferrier