Drug and Alcohol Dependence 150 (2015) 85–91

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Smoking and potentially preventable hospitalisation: The benefit of smoking cessation in older ages

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ARTICLE INFO

Article history:
Received 21 October 2014
Received in revised form 13 February 2015
Accepted 14 February 2015
Available online 4 March 2015

Keywords:
Smoking
Preventable hospitalisation
Rate advancement period
45 and Up Study

ABSTRACT

Aims: Reducing preventable hospitalisation is a priority for health systems worldwide. This study sought to quantify the contribution of smoking to preventable hospitalisation in older adults and the potential benefits of smoking cessation.
Methods: Self-reported smoking data for 267,010 Australian men and women aged 45+ years linked with administrative hospital data were analysed using Cox's models to estimate the effects on risk of hospitalisation for congestive heart failure (CHF), diabetes complications, chronic obstructive pulmonary disease (COPD) and angina. The impacts of smoking and quitting smoking were also quantified using risk advancement periods (RAP).
Results: The cohort included 7% current smokers, 36% former smokers and 57% never smokers. During an average follow-up of 2.7 years, 4% of participants had at least one hospitalisation for any of the study conditions (0.8% for CHF, 1.7% for diabetes complications, 0.8% for COPD and 1.4% for angina). Compared to never smokers, the adjusted hazard ratio for hospitalisation for any of the conditions for current smokers was 1.89 (95% CI 1.75–2.03), and the RAP was 3.8 years. There were strong dose-response relationships between smoking duration, smoking intensity and cumulative smoking dose on hospitalisation risk. The excess risk of hospitalisation and RAP for COPD was reduced within 5 years of smoking cessation across all age groups, but risk reduction for other conditions was only observed after 15 years.
Conclusion: Smoking is associated with increased risk of preventable hospitalisation for chronic conditions in older adults and smoking cessation, even at older ages, reduces this risk.

1. Introduction

Preventable hospitalisations are those that might be avoided through prevention and management in primary care, and rates of these admissions are used internationally as an indicator of health system performance (Jorm et al., 2012). Preventable hospitalisations account for around 10% of total hospital stays and total hospital expenditure (Stranges and Stocks, 2008), and reducing them is a priority for health systems worldwide (Muenchberger and Kendall, 2010).

The chronic conditions included in commonly used definitions of preventable hospitalisation include congestive heart failure (CHF), diabetes complications, chronic obstructive pulmonary disease (COPD) and angina, all of which are smoking-related. Accordingly, there is clear potential to reduce the rate of these hospitalisations through interventions to promote smoking cessation (Jackson et al., 2001). The majority of preventable hospitalisations for chronic conditions occur among people aged 65 years and over (Stranges and Stocks, 2008). While it has been clearly demonstrated that quitting smoking at age 60 years or older reduces the risk of mortality from all causes and many smoking-related causes (Gellert et al., 2012; He et al., 2014), few population-based studies have quantified the benefits of "late" quitting for preventable hospitalisation outcomes. Existing studies of the relationship between smoking and preventable hospitalisation in older populations have been restricted to specific patient groups (Godtfredsen et al., 2002; Shah et al., 2010), have presented combined mortality and morbidity endpoints (Gellert et al., 2013b), or have not stratified according to age at quitting (Baumeister et al., 2007).

In this study, data from a large prospective cohort of Australian men and women aged 45 years and over, linked with hospital morbidity data were used to: (1) quantify the effects of smoking on

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http://dx.doi.org/10.1016/j.drugalcdep.2015.02.028
0376-8716/

risk of preventable hospitalisation (expressed both as hazard ratios [HRs] and risk advancement periods [RAP]) for CHF, diabetes complications, COPD and angina; (2) investigate the contributions of smoking duration and smoking intensity to these risks; and (3) investigate the impact of quitting smoking at older ages on risk of preventable hospitalisation.

2. Methods

2.1. Participants

This analysis was part of the Assessing Preventable Hospitalisation InDicators (APHID) study (Jorm et al., 2012). APHID uses linked survey and administrative data for participants in the Sax Institute's 45 and Up Study, a prospective cohort of 267,091 men and women aged 45 years and over and resident in New South Wales (NSW), Australia (Banks et al., 2008). Participants were randomly sampled from the database of the national health insurance scheme (Medicare Australia). Participants entered the study by completing a mailed self-administered questionnaire at study entry (between February, 2006 and April, 2009) and providing written consent for long-term follow-up and linkage of their health information to a range of routine health databases. People residing in non-urban areas and those aged 80 years and over were oversampled. The overall response rate for the 45 and Up Study is estimated to be 18% and the study included about 10% of the NSW population aged 45 and over.

2.2. Data collection

2.2.1. Social-demographic data. Exposure and confounding variables used in this analysis were derived from self-reported data from the 45 and Up Study baseline questionnaire collected at study entry (available at https://www.saxinstitute.org.au/our-work/45-up-study/), apart from the measure of remoteness of residence, which was assigned according to the mean score of Accessibility Remoteness Index of Australia Plus (ARIA+) for the Postal Area of the participant's address (AIHW, 2004).

Socio-demographic data included participants' educational level (did not complete high school, high school or equivalent, University or higher), marital status (single, married or partnered, windowed or separated), language spoken at home (English, language other than English), annual household income (<$10,000, $10,000–$29,999, $30,000–$49,999, $50,000–$69,999, $70,000 or more, and 'I would rather not answer the question'), and health insurance status (private health insurance with or without extras, Department of Veterans Affairs card, health care card, and none). Participants' self-reported weight (kg) and height (cm) without shoes were used to calculate body mass index (BMI, kg/m^2), which was classified into groups according to WHO categorisation: 'underweight' $\leq$18.5 kg/m^2, 'healthy weight' <18.5–25 kg/m^2, 'overweight' 25.1–30 kg/m^2, and 'obese' >30 kg/m^2.

A score was generated for participants' number of positive health behaviours based on meeting recommendations for five behaviours (less than 14 alcohol drinks per week, more than 2.5 h of intensity-weighted physical activity over at least 5 sessions per week, at least 2 servings of fruit and 5 servings of vegetables per day, less than 8 h of sitting and not less than 7 h sleeping time per day) (Tran et al., 2014).

2.2.2. Smoking history and derivation of smoking variables. Current smoking status was based on responses to the questions "Have you ever been a regular smoker?", and (if yes) "Are you a regular smoker now?" Current and former smokers were asked further detailed questions about their smoking history, including the age at which they started smoking regularly, the age at which they stopped smoking regularly (for former smokers) and the average number of cigarettes or pipes/cigars they smoked each day.

Smoking duration was defined as the difference between starting age and either quitting age (former smokers) or current age (current smokers). Smoking intensity was calculated as the number of cigarettes and pipes/cigars smoked each day. Cumulative number of pack-years of tobacco exposure was derived by dividing the number of cigarettes and pipes/cigars smokes average each day by 20 and multiplying by the total number of years smoked. Time since quitting smoking was calculated as the difference between the age at which former smokers had stopped smoking regularly and their current age. For categorical analyses, each of the above smoking measures was categorised into quartiles. Participants with missing smoking data were excluded from the analyses.

2.2.3. Outcomes. Incident preventable hospitalisations for CHF, diabetes complications, COPD and angina were ascertained using linked hospital morbidity data, which captures all separations from public and private sector hospitals in NSW, based on the ICD10-AM diagnosis codes specified in the 2012 Australian National Healthcare Agreement potentially preventable hospitalisation indicator (NHA, 2012). Hospital morbidity data and death registration records were linked to the baseline data from the 45 and Up Study by the Centre for Health Record Linkage (http://www.cherel.org.au/) using probabilistic record linkage methods and commercially available software.

2.2.4. Statistical analysis. Participants were followed from the date of recruitment to either the date of first hospitalisation for each of the study conditions (CHF, diabetes complications, COPD and angina) or death or 30 December, 2010 (the last date to which hospital data were available), whichever occurred first. Separate analyses were run for each smoking variable (smoking status, smoking duration, smoking intensity, cumulative smoking dose and time since quitting smoking) and for each condition.

All participants were included in analyses of the association between smoking and preventable hospitalisation, with never-smokers as the reference group, except for analyses of time since quitting, where current smokers were used as the reference group. Cox proportional hazards models with age as the underlying time variable (Thiebaut and Benichou, 2004) were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for risk of hospitalisation. To assess the dose-response relationship between smoking variables and risk of hospitalisation, smoking duration (per 10 years), smoking intensity (per 10 cigarettes/day), cumulative dose (per 10 pack-years) or time since quitting (per 10 years) were included in models among ever-smokers only.

A number of variables were considered to influence both smoking and the risk of hospitalisation (Tran et al., 2014). In this analysis, we included age, sex, level of education, marital status, household income, speaking a language other than English at home, private health insurance status and remoteness of residence as social-demographic characteristics; and body mass index, number of positive health behaviours and prior admission in the 12 months prior to study entry as health and behavioural characteristics of the study participants. For present and former smokers who did not report the number of cigarettes smoked per day ($N = 1475$, 1.3% of the population who reported ever smoking), median values for smoking intensity in the population were assigned (20 cigarettes per day for men and 15 cigarettes per day for women). This imputation had negligible impacts on the overall risk estimates.

Point estimates of risk advancement periods (RAP) for each smoking variable were derived from multivariable Cox models as the ratio of the regression coefficients for smoking exposure (by category) to the regression coefficient for age (as a continuous variable). Confidence intervals for RAP were calculated using variance and covariance estimates for regression coefficients (Brenner et al., 1993). Values of RAP describe how much sooner a given risk of hospitalisation is reached among exposed than among unexposed individuals: positive RAPs suggest the risk will be advanced to younger ages, whereas negative RAPs suggest the risk will be postponed to older ages (Liese et al., 2000).

To study the relative importance of smoking intensity and smoking duration on risk of hospitalisation, effect modification analysis was conducted for the effect of smoking intensity (median cut-off: 15 cigarettes per day) and duration of smoking (median cut-off: 25 years). RAPs for time since quitting smoking were also estimated according to strata of age at study entry (<65, 65–74 and $\geq$75 years).

To assess the potential impact on our estimates of quitting smoking in response to a recent diagnosis of the study conditions or other smoking-related diseases ("sick-quitter bias"; Sargent et al., 2012), sensitivity analyses were performed that combined former smokers who had quit less than 5 years ago with current smokers.

All analyses were performed using Stata 12.0. A significance level of $P < 0.05$ was used for all comparisons.

3. Results

Of the 267,091 participants in the 45 and Up Study, 60 participants were excluded because of missing date of study entry and a further 21 were excluded because of possible inconsistent linkage, leaving 267,010 eligible participants included in this analysis. The mean age of participants was 63 years (standard deviation 11 years). Women comprised nearly 54% of the cohort.

Over an average of 2.7 years follow-up (interquartile range: 2.3–2.9 years), 11,035 (4.1%) participants were admitted to hospital at least once for any of the study conditions (0.8% for congestive heart failure, 1.7% for diabetes complications, 0.8% for COPD and 1.4% for angina) (Table 1). There were significant differences between participants who were hospitalised and those who were not in terms of age, gender, BMI, level of education, marital status, household income, private health insurance, number of positive health behaviours and a history of preventable hospitalisation for the same condition in the past 12 months (Table 1). Residents of remote areas were more likely than those living in metropolitan areas to be hospitalised for CHF or COPD; but this was not observed for diabetes complications or angina. People who spoke a language other than English were more likely than English-speakers to be admitted for CHF and diabetes complications, but not for COPD and angina (Table 1).