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Effects of an integrated respiratory service on COPD hospital admissions in England: an interrupted time series analysis

Abstract

Objective

To investigate the effects of an admission avoidance (AA) pathway within a new integrated respiratory service on the number of COPD-related hospital admissions in England.

Methods

We used interrupted time series analysis to estimate the effects of the AA pathway on COPD hospital admissions, length of stay, and 30-day readmissions. We included all unplanned admissions with COPD as primary diagnosis using Hospital Episode Statistics, comparing the intervention region with a demographically similar control region in the two years before and one year after the implementation of the new service.

Results

Unplanned hospital admissions for COPD exacerbations followed a clear seasonal pattern, peaking in early winter. We found no evidence that the AA pathway influenced the rate of hospital admissions or 30-day readmissions. We found weak evidence of a trend change in length of stay following the launch of the AA pathway.

Conclusion

Our study adds to the growing body of evidence that suggests that additional AA capacity alone does not lead to a measurable reduction in admissions or length of stay. Further investigation is required to understand the reasons why. A longer follow-up may be required to see some of the potential benefits.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a chronic lung disease, usually caused by smoking.[1] In 2017, COPD was responsible for 15.4% of global disability–adjusted life years and was the fifth leading cause in death globally. Many patients suffer from frequent exacerbations of the disease (acute worsening of symptoms) requiring immediate treatment.[2] In England, COPD is the most common reason for hospital readmission, with 24% of patients being readmitted within 30 days of discharge and 43% within 90 days of discharge.[3] Thus, COPD represents a high health care burden.

It has been suggested that integrated care pathways (ICPs) can improve access to care and the quality of life,[4] which can benefit patients and may reduce excessive COPD-associated health care costs. Integrated health services have been defined as services that are managed and delivered in a way that ensures people receive a continuum of health promotion, disease prevention, diagnosis, treatment, disease management, rehabilitation and palliative care services, at the different levels and sites of care within the health system, and according to their needs, throughout their whole life.[5] ICPs are increasingly used to bring together different healthcare organisations, linking community based and hospitals providers, to provide the best possible care, "delivered by the most suitable health professional, at the optimal time, in the most suitable setting" (Page 2, Paragraph 3.1).[6] They are also seen to offer the potential for efficiency savings, freeing up clinical resources from hospitals and other health care sites. The development of ICPs is policy priority in England and elswhere.[7, 8] However, clear evidence of their effectiveness is as yet lacking.[9, 10]

We here report on an admission avoidance (AA) pathway within a new integrated respiratory service in England, covering mixed urban city and rural population of around 300,000. The service involved a not-for-profit community provider and a respiratory department of an

acute-care hospital. The AA pathway was one of the three pathways delivered by the hospital in collaboration with the community provider (Box 1). Specifically, we investigated the effects of the AA pathway on the rate of hospital admissions, 30-day readmissions, and length of stay (LOS) of COPD patients using interrupted time series analysis. This study was part of a wider evaluation of the integrated respiratory service. A qualitative study was also undertaken to explore the integration process from the perspectives of staff and purchasers involved in the new service.[11] We used generic names for the organisations involved in this study to protect the anonymity of the participants in the qualitative study.

We wanted to determine if the AA pathway would cause a reduction in the number of admissions and readmissions, because of increased support for patients in the community. We also expected a potential reduction in LOS of COPD patients because the support from the community provider should have freed up capacity of the hospital staff.

Methods

Data sources

COPD hospital admissions were identified using the Hospital Episode Statistics (HES) Admitted Patient Care. HES is a routinely collected dataset that records all episodes of care per consultant team provided to patients admitted to National Health Service (NHS) hospitals in England and NHS-funded patients treated in the independent sector. Diagnoses are recorded per episode using the International Classification of Diseases (ICD).

Study population

The study population comprised adult patients (≥18 years) admitted to hospital with a primary diagnosis of COPD (ICD-10 codes J44.0, J44.1, J44.8, J44.9), where the admission was unplanned (HES codes ADMIMETH 21-29), registered at GP practices within the intervention region or one of the control regions, between December 2014 and November 2017 (Figure

1). Complete years of data before and after the start of the intervention allowed us to account for seasonal effects. The control region included 10 different regions in the UK that are demographically most similar to the intervention region. The similar regions were selected based on eleven variables with percentage weightings: Index of Multiple Deprivation (25%); the total population registered with GP practices (15%); percentage aged 18-39 (10%), aged 65-84 (10%), aged 85+ (10%); percentage who live in rural areas (15%); percentage who said they are white non-British (3%), mixed (3%), Asian (3%), black (3%), Arab or other ethnic origin (3%) provided by NHS Rightcare (who publish a list of demographically similar CCGs per CCG annually according to the above mentioned criteria).[12]

[Figure 1 about here]

Outcomes

The primary outcome was unplanned admission with COPD as primary diagnosis (admissions per 10,000 registered COPD patients) after the launch of the AA pathway (November 2016). Secondary outcomes were LOS in days and 30-day readmissions. Patients staying >30 days were excluded from the LOS analysis to partially account for the positive skew in the LOS data and because they represent highly unusual cases. To calculate admission rates, we used yearly counts of registered COPD patients per region reported by the Quality Outcomes Framework (QOF) as the denominator.[13] The QOF is a system for the performance management and payment of GPs, introduced in 2004, intended to improve the performance of primary care in the UK. Patients from GP practices that did not report to QOF in the respective years were excluded from the analysis (Online supplement, Table S1).

To account for multiple episodes per admission, we limited our dataset to one episode per admission by ordering the data by the number representing the order of care episodes and removing any additional rows with the same encrypted HES ID and admission date. We used

the first episode for admission data and the last episode of care for LOS, because spell duration is often only recorded in the last episode. Readmissions were defined as any COPD-related hospital admission of the same patient within 30 days of the start of the previous COPD-related admission.

Statistical methods

T test and Chi squared test were used to compare the intervention and control regions for continuous and categorical demographic variables, respectively. P-values <0.05 were regarded as statistically significant. Interrupted time series (ITS) with a control group, as described by Wagner et al.[14] was used to determine whether the implementation of the AA pathway affected the level and trend of unplanned COPD related hospital (re)admissions, and LOS. We used generalized least squares (fit by maximum likelihood) to fit segmented regression models to estimate the level and trend in admission rate or mean LOS before the launch of the AA pathway and the changes in level and trend following the launch. The ten similar regions served as one control region and helped determine whether any changes in COPD hospital admissions were specific to the intervention region.

We used bimonthly timepoints to increase the number of observations per timepoint and achieve more robust estimates. Admissions for COPD are higher in winter months,[15] so we added a dummy variable for winter months (December-March) to account for this effect. The effect of winter was also investigated in the secondary outcomes but was only included in the final model if it improved the model fit significantly. All models were checked for autocorrelation, using the Durbin-Watson statistic and visual inspection of the autocorrelation function plots (Online supplement, Table S3, Figures S1-3). Terms to account for autocorrelation were added to the models accordingly. The analysis was performed in Stata[16] and R[17] (packages *readxl*[18], *nlme*[19], *car*[20], *tibble*[21]).

Results

Demographic characteristics

COPD prevalence was similar between the intervention and control regions and rose from 140 to 150 per 10,000 inhabitants in the control region and from 147 to 160 per 10,000 inhabitants in the intervention region between December 2014 and November 2017. The percentages of hospital admissions of men and women, and average age were similar in both regions. There were significantly fewer hospital admissions of non-white patients in the intervention region. However, there was a substantial number of patients with unknown ethnicity, especially in the intervention group (17% missing in the intervention region and 5% missing in the control region), which may have affected the results (Table 1).

[Table 1 about here]

Hospital admissions

Table 2 shows the results of the interrupted time series analysis for each of the three outcome measures. Looking at hospital admissions first, we find the absolute number of bimonthly admissions ranging from 65 to 133 in the intervention region and from 327 to 804 in the control region (Online supplement, Table S2). Winter (December-March) had a significant effect on the rate of admissions in both regions (54 additional bimonthly admissions, 95% CI 27-81, $p<0.001$). At the start of the study period (Dec 2014-Jan 2015), there were 85 more COPD-related admissions per 10,000 COPD patients in the intervention region compared to the control (95% CI 31-138, $p=0.004$). However, there was no significant change in level or trend in either region after the implementation of the AA pathway (Table 2; Figure 2) (also: Online supplement, Table S4, Figure S4).

[Table 2 about here]

[Figure 2 about here]

Length of stay

Turning to length of stay we note that 196 admissions had to be excluded because LOS exceeded 30 days (1.6% of observations from the intervention region and 1.9% from the control region). The excluded patients were older than those included in the analysis (4.2 years, 95% CI: 3.4, 4.9, t=11.1, P<0.001), but the distribution of sex (Chi2=1.380, P=0.240) and ethnicity was similar (Chi2= 3.207, P=0.201).

At the start of the study period, the mean LOS was 2.3 days shorter in the intervention than in the control region (95% CI 1.9-2.7, p<0.001) (Figure 3). However, over the two-year pre-intervention period (until October 2016), LOS increased by 1.7 days (95% CI 0.6-3.0 days, p<0.001) in the intervention region, whereas in the control region LOS decreased by 0.7 days (95% CI 0.2-1.3 days, p=0.014). After the launch of the AA pathway, there was a nonsignificant reduction in LOS of 0.23 days (95% CI -0.47, 0.02, p=0.08) compared to the control region (Table 2; also Online supplement, Table S5, Figure S5).

[Figure 3 about here]

30-day readmissions

The absolute number of bimonthly readmissions ranged from 5 to 16 in the intervention region and from 35 to 123 in the control region (Online supplement, Table S2). In both regions, 1 in 10 patients admitted in one month was readmitted within the next 30 days. This rate did not significantly change over time and did not differ between the two regions (Figure 4). We found no evidence of an effect of the implementation of the AA pathway on the rate of 30-day readmissions (Table 2; also Online supplement, Table S6, Figure S6).

[Figure 4 about here]

Discussion

This study assessed the effectiveness of an admission avoidance pathway within an integrated respiratory service hospital utilisation among people with COPD in England, UK. The integrated service moved aspects of respiratory care into the community to improve accessibility of services for COPD patients and added capacity to respiratory care, with the overall aim to reduce demand on hospital care. However, we found no evidence that the AA pathway influenced the rate of unplanned hospital admissions or 30-day readmissions within the first year post-intervention. We found weak evidence that the trend in LOS changed following the launch of the AA pathway, meaning that the increase in mean LOS over time, which was observed in the pre-intervention period, discontinued after the launch of the AA pathway.

Many countries are implementing admission avoidance schemes, seeking to move services nearer to peoples' homes that would otherwise have required acute hospital in-patient care and so reduce demand on emergency hospital care.[22] However, the evidence on the effectiveness of such schemes remains limited, with a Cochrane review of related interventions finding no significant effect on the number of admissions.[22]

The present study used real world implementation data in order to assess the impact of an AA pathway within a newly commissioned integrated respiratory service. The AA pathway in itself was an integrated care pathway, integrating hospital and community care. However, a recent report on implemented integrated care pathways found limited evidence that patients are benefitting from better integrated care. For instance, potentially preventable emergency admissions have not improved between 2011 and 2019 despite numerous integrated care initiatives.[23] Partnership cultures which lead to a hierarchy between partner organisations[24]

and inter-organisational mistrust[25] have been identified as the key barriers in integrated programmes by previous studies.

The main strength of this study is the use of interrupted time series analysis (ITS), which is one of the most robust design to investigate the effect of an intervention using observational data.[26] ITS models using a control group can provide the highest level of evidence when randomized controlled trials are not feasible,[14] because it accounts for most confounding in its design. The only remaining sources of confounding are events that occur at the same time as the intervention and that do not occur in the control region. It is unlikely that the distribution of age, sex, and deprivation changed in November 2016 in the intervention region (and not in the control regions).

Limitations of our study include the limited follow-up period and low number of observations in the intervention region. A longer follow-up may be needed to detect the impact of the AA pathway on admissions. We did not have clear data on how well the services were integrated or how long it took before the services were fully operational. It may have taken a few weeks or months to embed the organisational changes, causing a time lag between the implementation of the services and the services' effect, which we could not account for in our models.[14] Due to a relatively low number of observations, there was substantial variation between timepoints. This impeded the sensitivity of our analysis, as we could only detect large effects, and made it impossible to do subgroup analyses.

Additional pulmonary rehabilitation capacity was implemented shortly before the AA pathway. Because there was only a short period between the launch of both new services, it was not possible to disaggregate the distinct effects of each service. However, it is unlikely that the launch of pulmonary rehabilitation would have masked an effect of the AA pathway. Elsewhere, pulmonary rehabilitation was shown to improve health-related quality of life and

exercise capacity and to reduce the risk of readmission to hospital.[27] Therefore, pulmonary rehabilitation would have had an added effect to the AA pathway in reducing admissions instead of masking it.

The use of routine health care data allowed us to compare the intervention region to several other regions in England. However, routine data have several limitations such as missing data and variation in coding of primary diagnoses. For instance, by limiting the analysis to COPD as primary diagnosis we potentially missed patients that were admitted with pneumonia as a direct result of COPD (who would have had pneumonia as primary diagnosis). Finally, the AA pathway may have had other beneficial effects not captured by our primary and secondary outcomes, such as perceived quality of care, patient satisfaction, or access to care. Because we were restricted to routine data, we were not able to investigate other outcomes.

Conclusion

We found little evidence that the admission avoidance pathway within an integrated respiratory service had an impact on hospital admissions for COPD. Further investigation is required to understand the reasons why. Given the relatively short time period after the service was introduced, it may be too soon to see some of the potential benefits. Our study adds to the growing body of evidence that suggests that additional AA capacity alone does not lead to a measurable reduction in admissions or length of stay. We provide a methodologically robust template (using a large, demographically matched, case control time series) which those responsible for planning or purchasing health services as well as researchers could look to adopt when evaluating AA initiatives internationally. Decision-makers may want to ensure that any additional AA capacity is designed, commissioned, and integrated with existing services and providers.[11]

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Table and figure legends

Table 1. Demographics study population

* Excluding admissions where ethnicity is unknown.

Table 2. Results of the interrupted time series analysis using linear models

AA: admission avoidance pathway. 95% confidence intervals in brackets. * p<0.1

Figure 1. Study profile

Figure 2. Hospital admissions. Rate of hospital admissions (per 10,000 COPD patients) in the intervention region (red line) and in the control region (blue line) from Dec 2014 to Nov 2017. The Home oxygen pathway was launched in April 2016, the additional pulmonary rehab service in October 2016, and the admission avoidance pathway in November 2016.

Figure 3. Mean length of hospital stay (capped at 30 days) in the intervention region (red line) and in the control region (blue line) from Dec 2014 to Nov 2017. The Home oxygen pathway was launched in April 2016, the additional pulmonary rehab service in October 2016, and the admission avoidance pathway in November 2016.

Figure 4. 30-day readmissions as proportion of total COPD-related admissions in the intervention region (red line) and in the control region (blue line) from Dec 2014 to Nov 2017. The Home oxygen pathway was launched in April 2016, the additional pulmonary rehab service in October 2016, and the admission avoidance pathway in November 2016.