Defining waiting times in NGH

The time spent by a patient in the Emergency Department is measured at several points, but there are two key metrics that can usefully be referred to as *waiting times*: the time from admission to first seeing a doctor t_{doctor} and the entire length of stay in the department t_{dept}.

The NHS commitment to a maximum four-hour waiting time for t_{dept} was introduced in 2004 and reaffirmed in June 2015 after Sir Bruce Keogh's review. Sheffield Teaching Hospitals NHS trust met the national standard required (which was lowered from 98% to 95% from 2010) every year until 2012/2013, but has struggled after this. Summary data for the trusts is published on the NHS England website (weekly before June 2015, monthly after this).

As an initial evaluation of the dataset, we consider the seven-day period ending 15/02/2015. The data from the NHS England website has 275 admissions for the trust that were not treated in less than four hours in the Type I Major Emergency Department, which matches the data from Northern General Hospital t_{dept} for this period. There were 2 admissions included that did not wait but were in the ED for more than four hours, in total 85 of 2486 admissions did not wait. These are excluded from the quantiles of Table 1 (if a patient DNW, the value for t_{doctor} is often repeated for t_{dept} in the dataset, perhaps this is a data recording policy).

0%	25%	50%	75%	89%
0	97	155	217	240

Table 1: Quantiles (in minutes) of total waiting time in the department w/e 15/2

Confounding

The choice of t_{dept} as a measure of waiting time measures the *complete patient experience*. However it seems to raise some interesting questions with some natural (parametric) types of analysis.

Intuitively, using t_{dept} rather than t_{doctor} introduces a second group of covariates that potentially confound waiting times: if a patient is discharged $t_{dept} = t_{doctor}$, but if a patient is e.g. admitted to NGH, this has a marked effect of t_{dept}. Furthermore, this introduces a correlation structure into the data, e.g. as multiple patients wait to be admitted to NGH.

For example, Goodacre S (2005) uses multivariate regression to analyse the most important predictors of waiting times. This paper takes a set of covariates all related to characteristics of patients *entering* the department, for example triage category, sex, day of admission, and assesses their usefulness in predicting waiting times. How the patient left the department is not included in the model, but might be an interesting extension. This is a potential

confounder if using t_{dept} as a measure of waiting time. For example departure to the fracture clinic is much faster than admittance to NGH, (considering the difference between t_{dept} and t_{doctor}); there were only two fracture clinic cases that had waiting times > 4 hours and both left the department immediately after seeing a doctor for the first time. One expects there is a relationship between triage category (entry) and fracture clinic (exit).

Of the patients that were in the department for four hours or more, 240/275 saw a doctor within four hours (and so were not immediately discharged). We can see how many people are in the department, and how many are waiting to see a doctor in Figure 1.

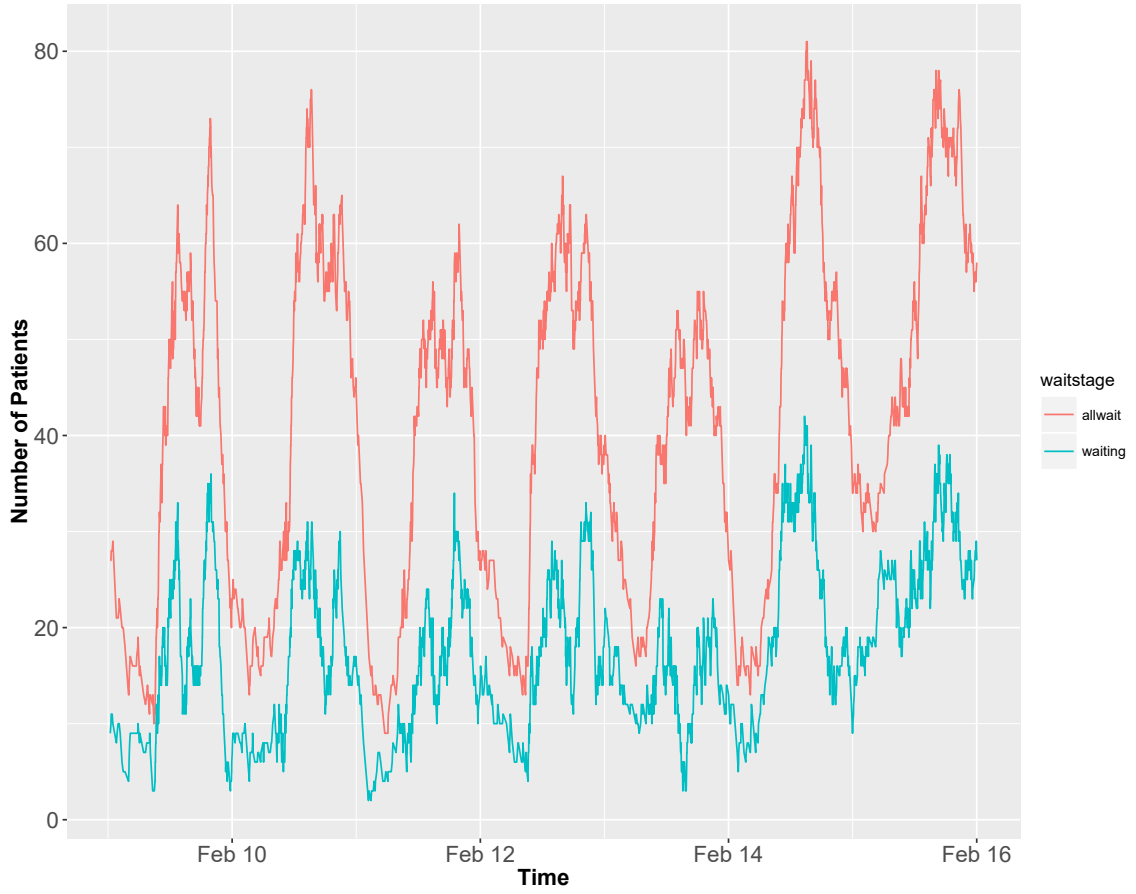

Figure 1: Patients queuing: to first see doctor (green) and all in department (red)

Correlation

As mentioned above, method of departure is strongly associated with waiting times. The Partial autocorrelation function for patients who were admitted to NGH is shown in Figure 2, with the corresponding time series it is based on. The first six lags are significant.

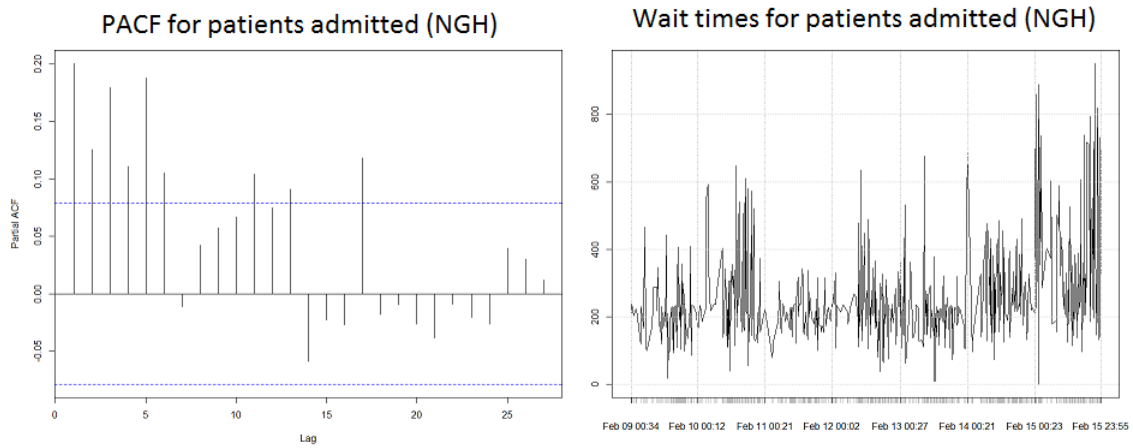

Figure 2: Correlation in Patient Waiting times (admit to NGH stratum)

Comments

- There are two possible structure of correlation in the data, entry condition and exit method.
- For regression type analyses of the entry-condition covariates on waiting times, time taken to see a doctor t_{doctor} may be a more robust response to measure than waiting time t_{dept}.
- It may be useful to model t_{dept} with focus on method of departure, either as covariates or attempting to build a mixture model. Perhaps with the intention of predicting large values of t_dept or trying to predict large values of method of departure from entry conditions, e.g. predict number of admissions to NGH from time of entry.
- Possible to consider queue size effects on t_{doctor} and hence t_{dept}

Concerns

- There is no case in the data of a patient who leaves without being seen by a doctor (e.g. after triage but before first being seen by a doctor) have these been excluded?
- This is a key area for the Department of Health and NHS England, where a great deal of work has already been done, and continues to actively be done. Most of this analysis publishes (non-parametric) summary statistics/data (analysing the correlation structure seems more relevant to regression-type approaches). Some concerns about duplicating/repeating part of this work.
- The Keogh review NHS England (2013) of Urgent and Emergency care completed in 2015 proposes system wide changes introduced over the next three to five years, intending to reduce waiting times in A&E, particularly by addressing cases that are immediately discharged (estimated at 40% headline figure quoted in the review, 48%

in NGH w/e 15th Feb). This might challenge the relevance of any analysis/techniques. However, could be an opportunity, for example it maybe possible to try to model the effect of reducing number of patients (e.g some of those who would be discharged) entering the department on t_dept. Perhaps patient education (come at a different time) or spending resources elsewhere would be effective?

References

Goodacre S, W. A., 2005. Who waits longest in the emergency department and who leaves without being seen? Emergency Medicine Journal 22.2, 93–96.

NHS England, November 2013. Transforming urgent and emergency care services in england. Last accessed 2015-04-22.
URL `http://www.nhs.uk/NHSEngland/keogh-review/Documents/UECR.Ph1Report.FV.pdf`