Cornwall Partnership Trust inpatients modelling

Project aim

This project sought to understand where in the CPT inpatient pathway there might be bottlenecks which are contributing to a lack of capacity in the system. The organisation would like to prevent any patients from being sent out of county due to the lack of an inpatient bed being available for them.

The parameters being altered in the model are:

- Inpatient bed capacity
- Intensive care bed capacity
- The rate at which patients are referred for admission
- The patient length of stay

Stopping the practice of sending patients out of county due to a lack of beds and preventing long waiting times for inpatient admission are aims expressed in the 2016 report titled 'Improving acute psychiatric care for adults in England' from the commission to review the provision of acute inpatient psychiatric care for adults led by Lord Crisp. This project has focused on enabling Cornwall Partnership trust to meet the aims of this report and the following findings demonstrate how key aspects of acute mental healthcare pathway could be changed to support this.

The findings presented here should be interpreted as general trends in the data. The data type and quality was not sufficient to produce highly accurate prediction however, the trends and relationships between the different system parameters are thought to be representative of the system. The findings will be discussed in terms of the trends in the data and not using exact values.

Model setup

The raw data used to parameterise the model is from the year 2015 only

The time units used in the model are days

A warm up period of 2 years is used to ensure data collection commences with the system in a stable state

The simulation is run for six years to ensure sufficient time for the variation in the system to be accounted for

Each scenario was run multiple times in a trial format to ensure a 95% confidence level in the results

Model assumptions

Leave taking is included in the patient length of stay

If no inpatient beds are available the patient is sent out of county

Patients returning from out of county have a 50% probability of being discharged immediately and a 50% probability of being admitted to an inpatient bed

Patients returning from the intensive care ward have bed priority over those returning from out of county and new referrals. Patients returning from out of county have priority over new referrals.

Scenarios

Inpatient bed capacity required to meet the current demand and achieve no patients being sent out of county for treatment

Patients are currently being sent out of county due to inpatient bed capacity not being able to meet demand. When the number of inpatient beds is the only simulation parameter altered the simulation indicted that approximately 45 new inpatient beds would be required to meet the current demand. These numbers are based on 78 inpatients beds currently being available. Figure 1 shows average inpatient bed use and the average out of county bed use with the current bed number (78 beds) marked in red and the level at which no patients out of county is achieved in green (123 beds).

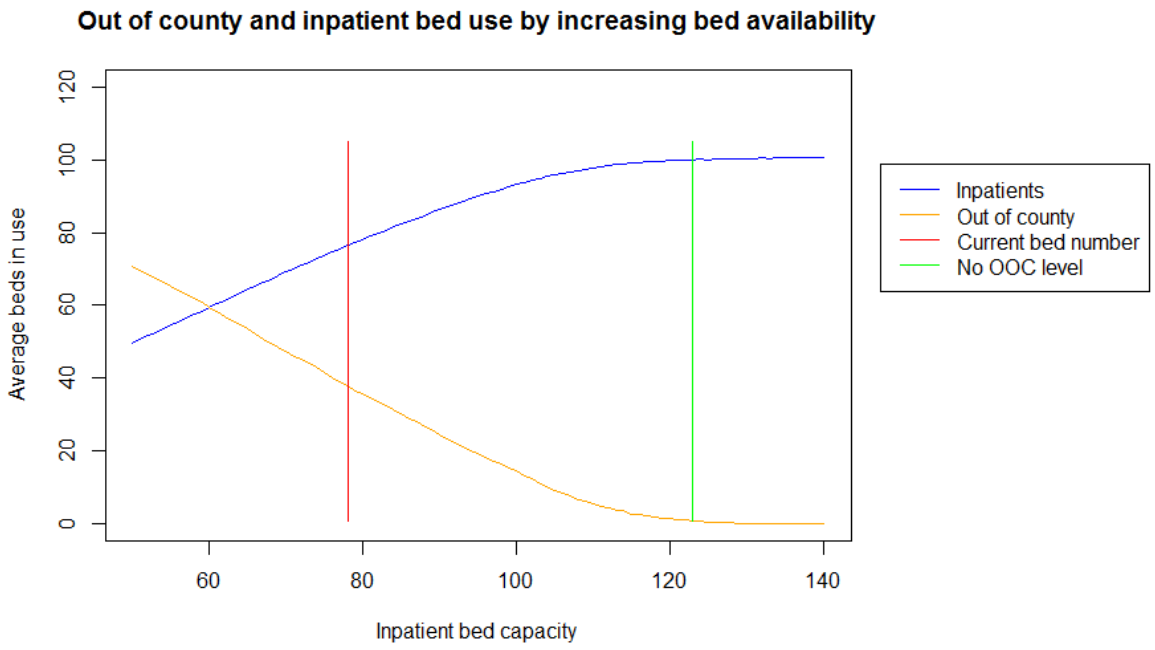

Figure 1 Average inpatient and out of county bed use by increasing bed availability

If the maximum values for the number of patients out of county and using inpatient beds are used instead of the averages then the number beds required to ensure demand can be met rises by half again to over 140 beds as shown in Figure 2

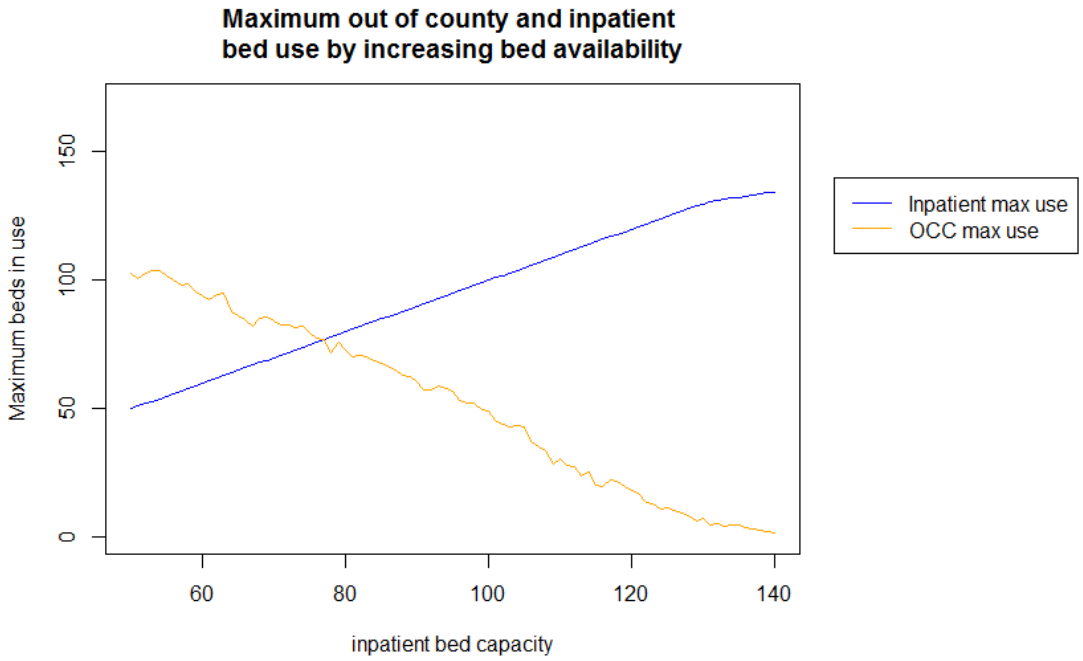

Figure 2 Maximum out of county and inpatient bed use by increasing bed availability

The second important aspect is to understand the impact on waiting times for admission. Figure 3 shows that as would be expected waiting times decrease as the number of beds increases but the decrease stops at approximately 112 beds. This shows that there are other limiting factors in the system and increasing bed capacity alone will not reduce waiting times to the required levels alone.

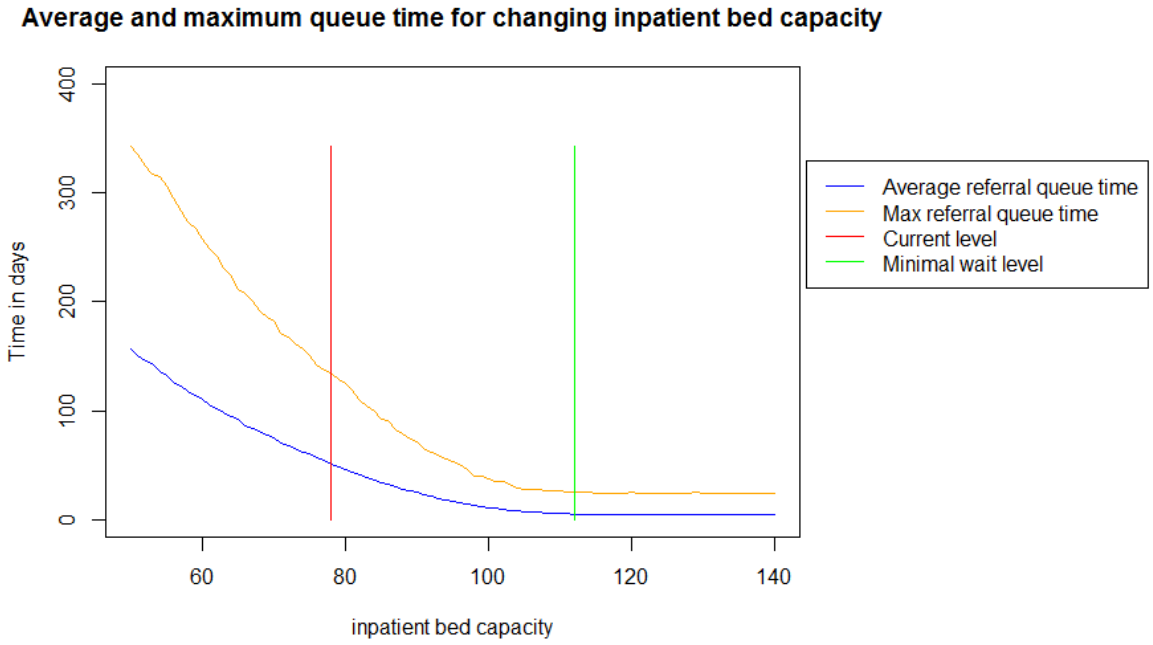

Figure 3 Average and maximum waiting times for inpatient admission by increasing bed capacity

The number of beds required to ensure that inpatient demand is met and no patients are sent out of county seems unfeasibly high. A large number of new bed spaces would be needed requiring significant capital investment.

Impact of intensive care capacity on intensive care bed use and the number of patients sent out of county

Based on 78 inpatient beds average intensive care bed use plateaus at 13 intensive care beds and out of county bed use at this point stabilises with an average of 71 patients being sent out of county (Figure 4). This indicates that the number of intensive care beds is not a limiting factor on the system and can be kept at 12 beds for the remainder of the simulation scenarios.

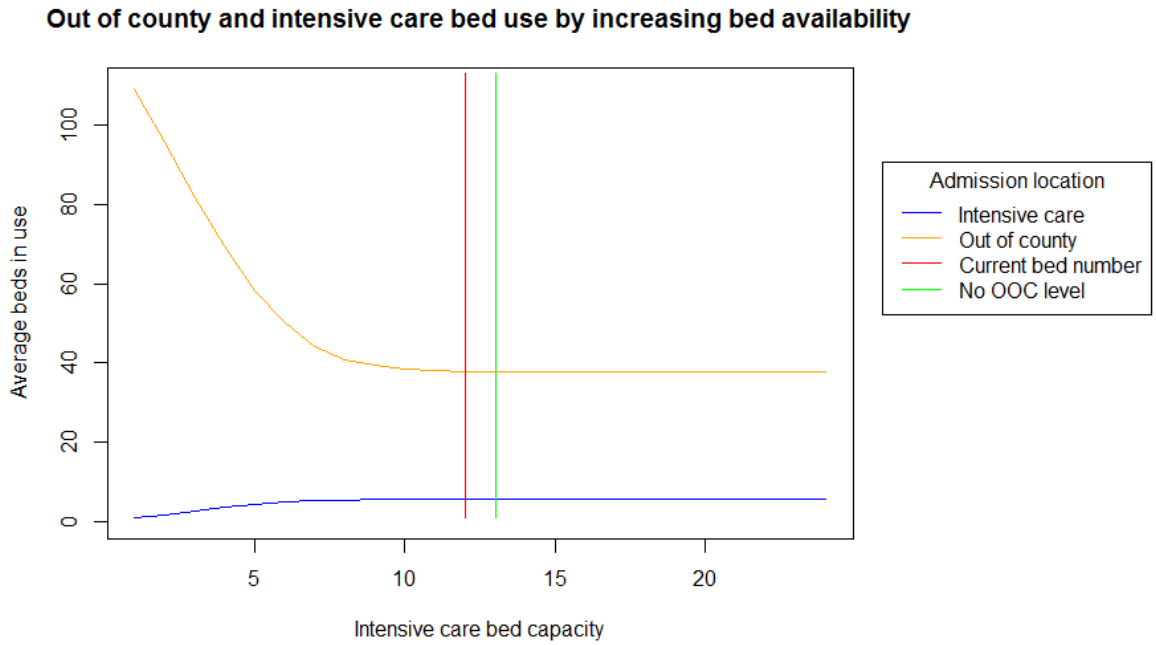

Figure 4 Average out of county and intensive care bed use by increasing bed availability

Changing the rate at which patients are referred for inpatient admission, its impact on inpatient bed use and the number of patients sent out of county

Increasing the time between patient arrivals reduces the average number of patients sent out of county and the average number of inpatient beds in use. As can be seen in Figure 5, the average time between patients being referred to inpatients has to double from 1.8 to 3.6 before no patients are sent out of county for treatment.

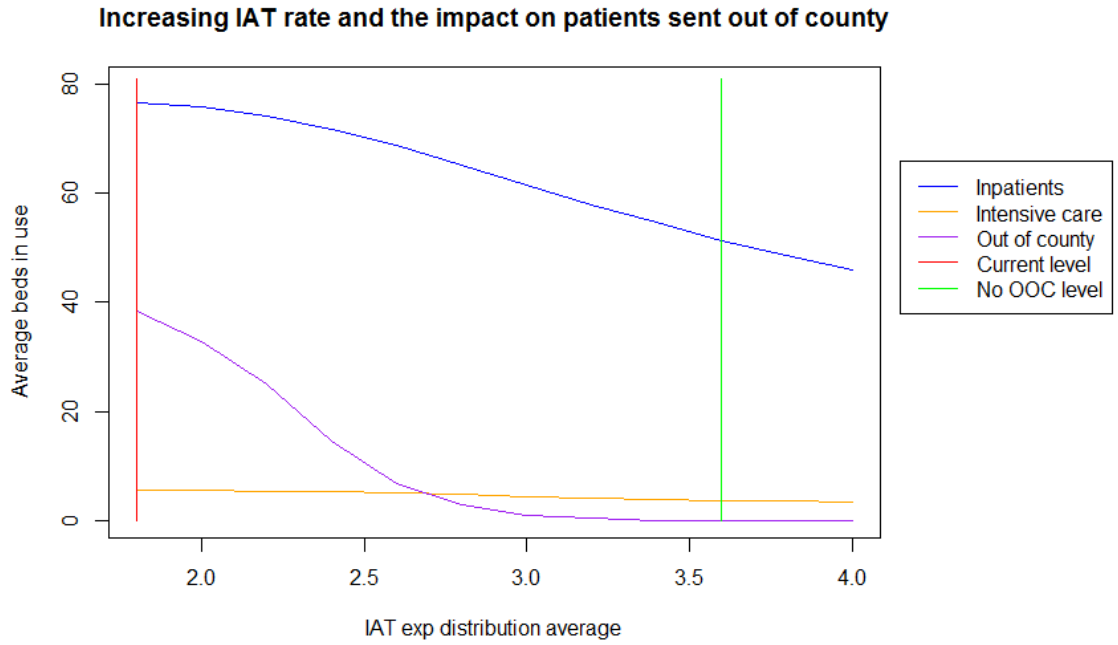

Figure 5 The impact of increasing patient inter arrival time on inpatient bed use and the number of patients sent out of county

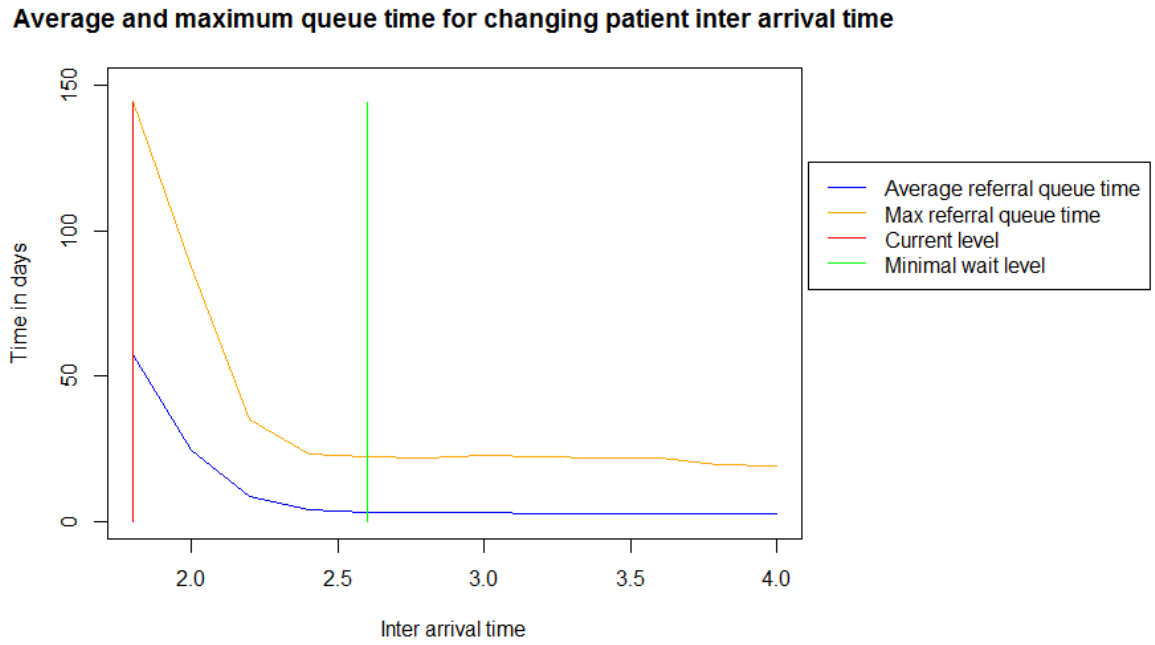

Figure 6 Average and maximum queue times for increasing patient inter arrival times

Queue times decrease most rapidly between the current level of 1.8 and 2.6 as can be seen in Figure 6. After this there are only small decreases in the time between patient referral for inpatient admission and their admission onto a ward.

The impact of reduced lengths of stay on inpatient bed use and the number of patients sent out of county

The average length of stay for a patient is described by an exponential distribution with an average of approximately 47 days. To achieve zero patients being sent out of county with the current situation of 78 inpatient beds the simulation indicates that the distribution average needs to be 22 days which is the equivalent of reducing patient lengths of stay by half (Figure 7).

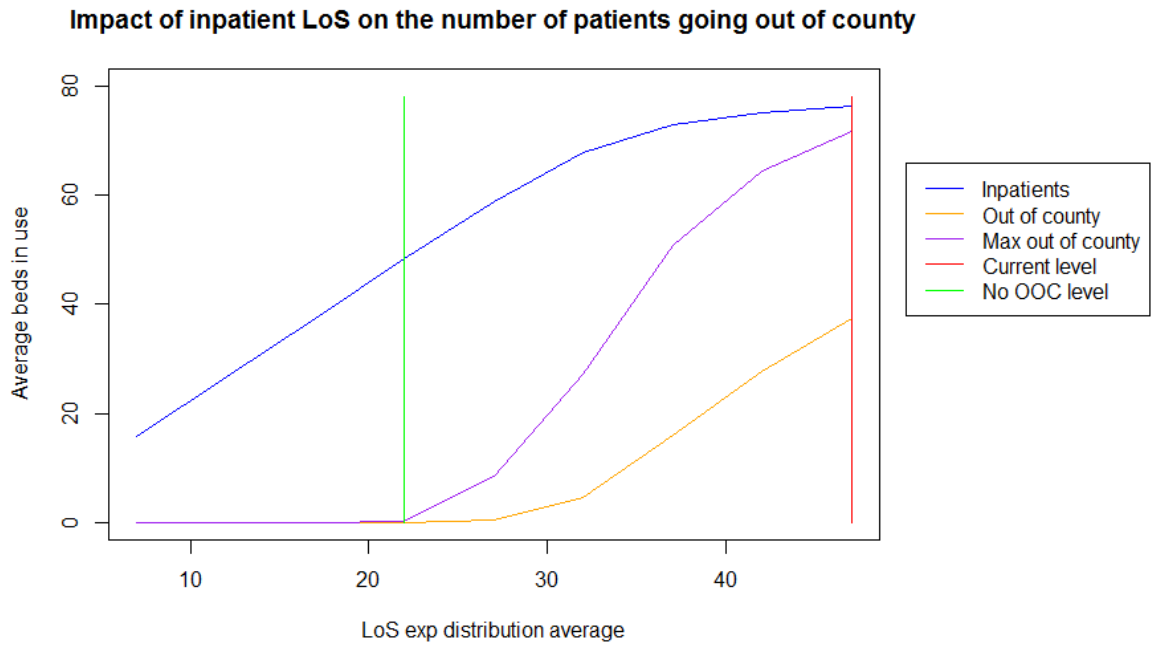

Figure 7 Impact of patient length of stay on the number of patient sent out of county

From the current queue times with the current patient length of stay the queue times reduce until the patient length of stay is about half its current level. Figure 8 shows that both the average and maximum queue times stabilise at this point.

When the number of inpatient beds is altered the amount that the patient length of stay needs to be changed to prevent patients being sent out of county reduces (Figure 9). The greater the number of inpatient beds the less that patient length of stay needs to be reduced. This indicates that using combinations of changes to patient length of stay and bed capacity can minimise the changes required to any singular aspect of the system. The final set of scenarios will outline a few possible trade-off combinations.

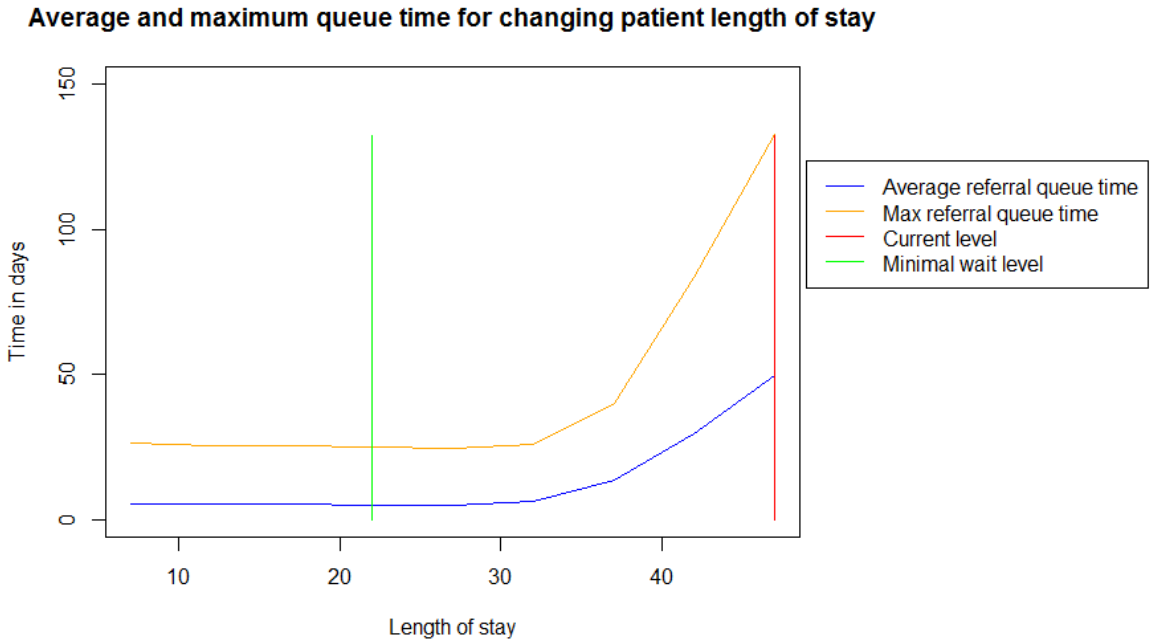

Figure 8 Average and maximum queue times by patient length of stay

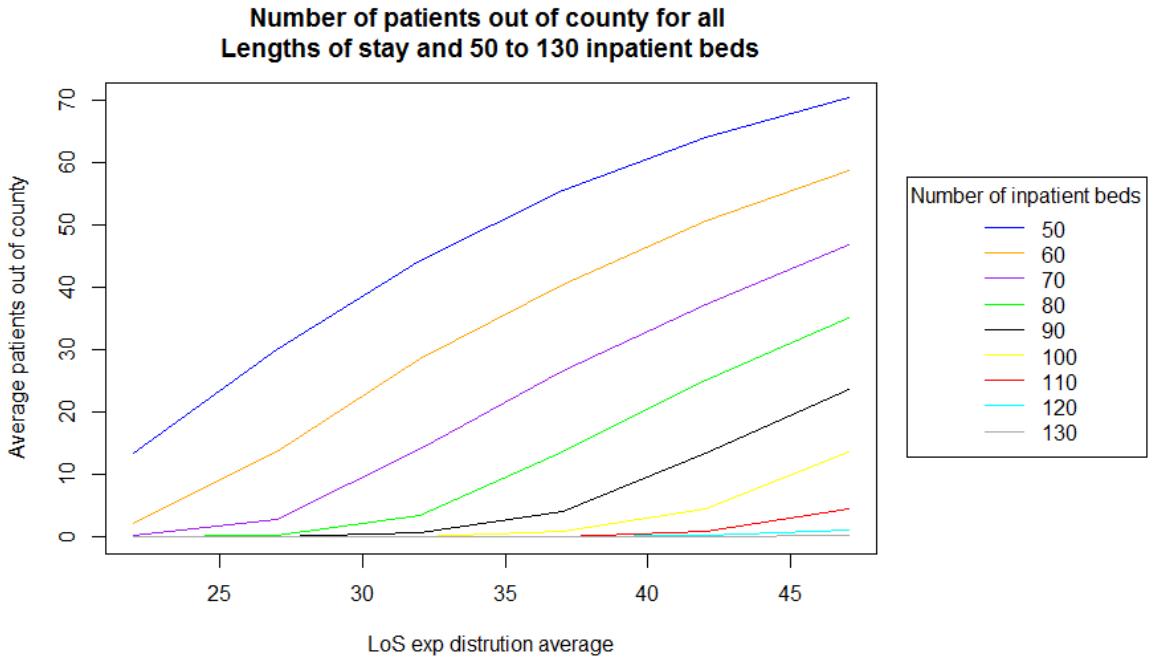

Figure 9 The number of patients sent out of county by change in length of stay and inpatient bed capacity

The combined impact of changing inpatient bed capacity, intensive care capacity and patient length of stay the rate at which patients are referred for inpatient admission

The following set of figures show combinations of inpatient bed capacity, patient inter arrival time and patient length of stay which minimise the changes required to any single component of the system. They also ensure that no patients are sent out of county and the time between referral for inpatient admission and their actual admission to a ward is minimised.

The four scenarios presented below are:

1. Base case scenario – the current system: IAT 1.8, LoS 47
2. Scenario 1: IAT 2.2, LoS 37
3. Scenario 2: IAT 2.6, LoS 37
4. Scenario 3: IAT 2.6, LoS 42

Intensive care bed capacity is kept at 12 beds as this was found to have negligible impact on the functioning of the system.

In each of the three scenarios maximum inpatient bed use stabilised at or less than 100 patients indicating that these are good scenario values to ensure that the number of inpatient beds required is not impractically high. The difference between the inpatient average and maximum use values seen in Figure 10 indicate that there would be sufficient spare capacity to allow for unforeseen spikes in demand.

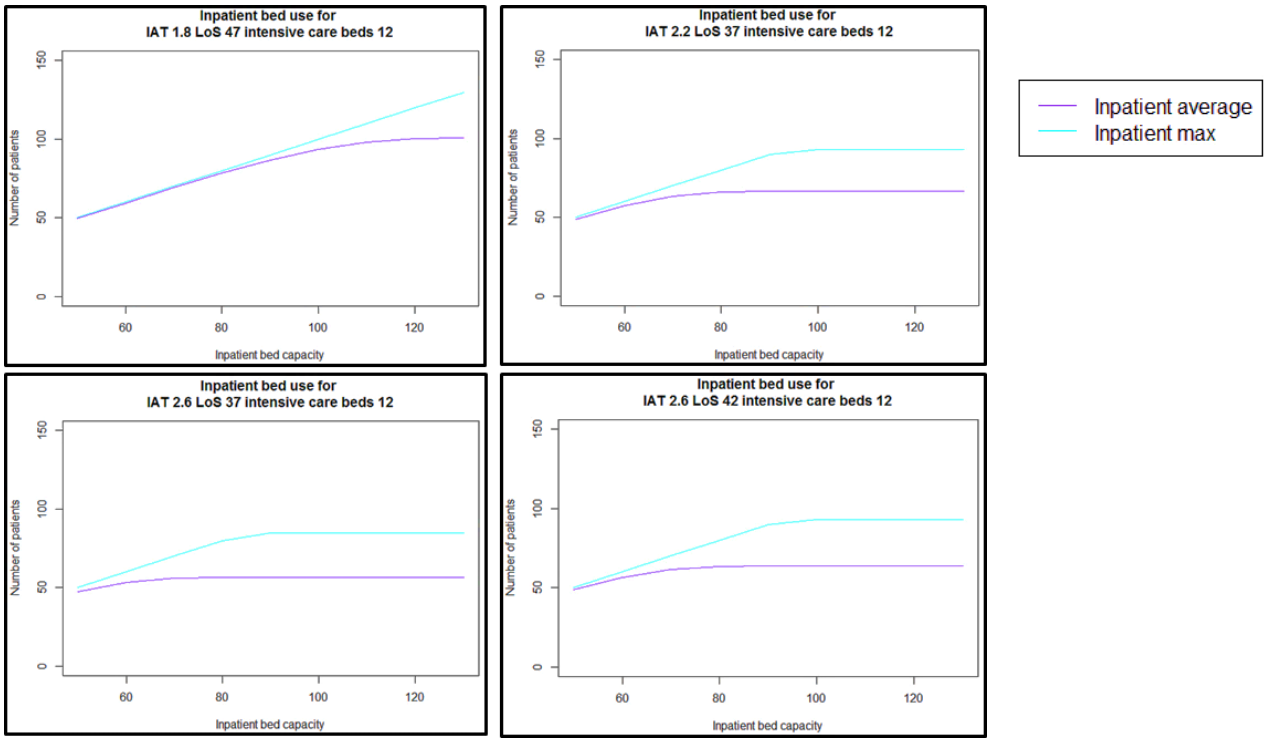

Figure 10 Inpatient average and maximum bed use for all scenarios (top left: base case, top right: scenario 1, Bottom left: scenario 2, bottom right: scenario 3)

To ensure that no patients were sent out of county for treatment in the base case scenario over 120 inpatient beds would be required. In scenarios 1 and 3 this would be between 90 and 100 beds and in scenario 2 between 80 and 90 beds. By reducing the rate at which patients are referred for inpatient admission and their length of stay the number of beds required to ensure all patients can receive an inpatient bed is greatly reduced (Figure 11).

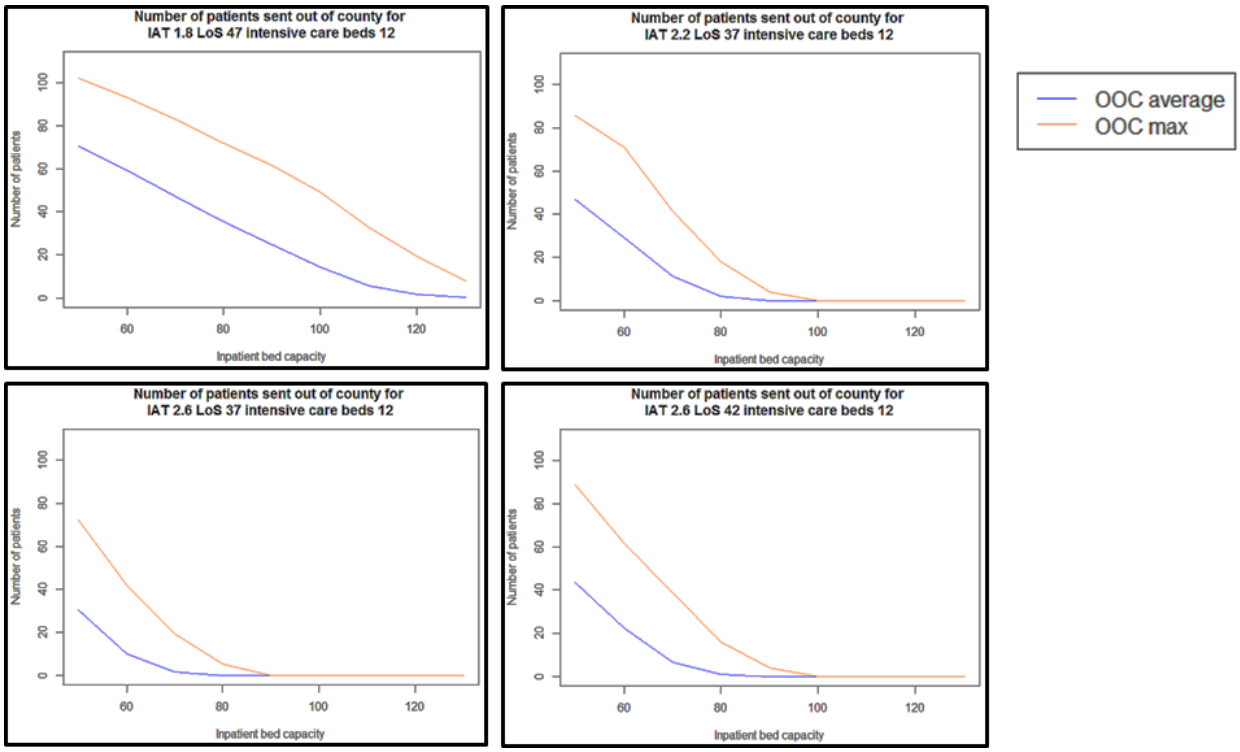

Figure 11 Average and maximum number of patients sent out of county for all scenarios (top left: base case, top right: scenario 1, Bottom left: scenario 2, bottom right: scenario 3)

Figure 12 shows that increased patient IAT and reduced LoS result in lower waiting times for inpatient admission across all three scenarios in relation to the base case. At inpatient bed capacities between 78 and 100 the waiting times for admissions are stable and at their lowest values.

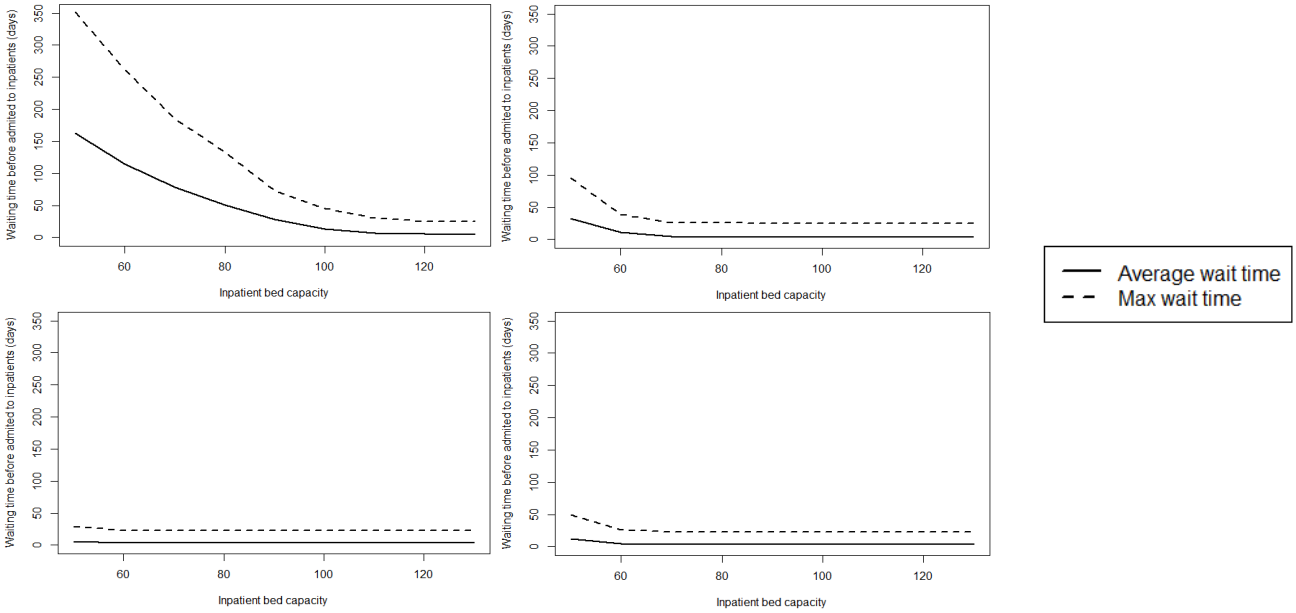

Figure 12 Average and maximum wait times between referral and admission for all scenarios (top left: base case, top right: scenario 1, Bottom left: scenario 2, bottom right: scenario 3)

Final recommendations

The most important finding to come out of this project has been that to ensure low waiting times and no patients being sent out of county changes are required to multiple part of the system. Changing only one aspect of the system can achieve these aims but the change would have to be so dramatic as to make it impractical.

Inpatient bed capacity, the rate of inpatient referral and inpatient length of stay are the three main drivers of the inpatient care system. By changing these three aspects of the system in combination the goals of low waiting times and no patients being sent out of county can be met.

Based on the three scenarios run where all three of these parameters are changed in combination changing the real world system by the following proportions will likely have the desired effect.

- Decrease the rate at which patients are referred for inpatient admission by between 20% and 40%. This is the equivalent of preventing the admission of 2 to 4 patients in every 10 patients
- Decrease patient length of stay by between 10% and 25%. Based on the current average length of stay of 47 days this would be a reduction of between 4.7 and 11.8 days
- Increase inpatient bed capacity to between 80 and 100 beds an increase of 2.5% and 28%.

The greater the change that can be achieved to any one of these aspects of the system the less change required to the other parameters. The findings above provide a guide to the inner dynamics of the acute care pathway particularly highlighting the non-linear dynamic in the system which means that the outcomes of this system cannot be predicted using simple averages and straight line graphs. Improved data collection and analysis will help aid the understanding of the inpatient adult acute care pathway as it is adapted and changed.