COMPLEXITY DTC MINIPROJECT PROPOSAL – ANALYSING AND FORECASTING LOAD ON A HOSPITAL MATERNITY UNITY

RESEARCH QUESTION

How accurately can we forecast the expected demand on a maternity unit?

BACKGROUND

Maternity units generally aim to use stable resourcing throughout the year. It has previously been reported [1] that different communities show different trends in seasonality of both births and preterm births (which require significantly more hospital resource).

We would like to investigate the potential for forecasting (at least one month in advance) demand on a maternity unit (University Hospital Coventry and Warwickshire). This forecast may take into account historic birth rate, local seasonality, weekly patterns, underlying trends, analysis of local pregnant population at any time (e.g. short term fluctuations of birth rate may be detectable by analysis of the number of women currently at different stages of gestation) and any other factors found to be significant (e.g. demographic changes in the local population). The forecast would give a range of expected number of deliveries each day.

Additionally we would like to investigate breaking down the forecast into sub-groups (e.g. normal unassisted delivery, Caesarean delivery, induced delivery, preterm delivery, etc) as different groups may show different weekly & seasonal patterns and may be detectable from examining the local population.

The research will be structured so that basic analysis (without subdivision) is performed first, followed by subdivision of the population of mothers. Complexity may be progressively introduced at this stage as known distributions will need to be adjusted as sub-groups are removed from the parent distribution.

DATA AND TECHNIQUES TO BE USED

A large amount of pre-cleaned data are publically available from HES online (http://www.hesonline.nhs.uk). These data include national and local birth rates (by day, month and year), gestational lengths, frequencies of major delivery types (spontaneous, induced, forceps, Caesarean, etc), frequency of complications. These available data will form the basis of the project but we may additionally use local hospital statistics where appropriate. Though new data may be collected from the hospital it should be possible to divide historic data into a large training set and a test set.

Techniques to be used will start with standard statistical and forecasting techniques (such as multiple regression analysis and Winter's seasonal forecasting), but may then go on to explore data simulation (Monte-Carlo simulation and/or discrete event simulation) or Bayesian statistics (the forecasting is likely to have to cope with some unknowns).

A preliminary literature review should be included at the start of the project.

WHO WILL USE AND BENEFIT FROM THIS PROJECT?

The data and analysis will have two uses:

1. As a standalone project demonstrating how accurately we may predict deliveries at UCHW maternity unit. We may then compare the expected demand with resource rosters to see if we have good matching of resource (across day and week) to demand. If appropriate this project could then form the basis of a stand-alone forecasting tool.
2. The project will feed into a larger project that is looking at patient flow and resourcing at UCHW maternity services. This larger project will use Discrete Event Simulation and Theory of Constraints to analyse (and improve) obstetric and midwifery service delivery at UCHW.

The potential beneficiaries of this project are (1) mothers and babies who may benefit from better planning and matching of resource to demand so that resources are available when needed, and (2) hospital trusts who benefit from better planning and matching of resource to demand so that resources are not being made available when they are highly likely not to be used.

DELIVERABLES

- Analysis of data to shown any patterns (daily, weekly, yearly, pulses or underlying trends) in data of all births or subsets of births.
- An algorithm to forecast range of expected births (of different types) by day at 1 and 3 months ahead.

EXTENSION TO PH.D. PROJECT

There are several possible ways in which this project may be extended into a Ph.D. project.

- Extension of forecasting to other parts of the maternity and newborn clinical pathway (e.g. forecasting load on neonatal services) and/or further breakdown of patient subgroups based on patient histories or known risk factors.
- Development of methods to help plan optimal resourcing around expected demand.
- Forecasting a clinical condition with a longer duration than pregnancy (e.g. forecasting demand for diabetic services based on local populations and possible trends).

REFERENCES

1. Darrow, L.A., et al., *Seasonality of birth and implications for temporal studies of preterm birth.* Epidemiology, 2009. **20**(5): p. 699-706.