

**Feasibility of modelling to predict
seasonal influenza like illnesses
in Western Australia
Part 2: Product evaluation
Forecast Pro XE**

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Key points

- Forecast Pro XE was used to conduct two different analyses:
 - Indicators related to influenza like illnesses (ILI) and
 - PMR measures
- The exercise suggests that the package is a useful tool involving the analysis of extended time series data and which had multiple data points and is characterised by seasonality patterns, such as the ILI data.
- The PMR data was characterised as having fewer data points, as the time series involved shorter time frames and this limited the reliability in undertaking predictions especially, beyond more than 6 months.
- The key and time consuming part of the process was compiling data sets in Excel and developing routines to deal with empty cells and null values, as otherwise without correction the application would eliminate such series from an analysis.
- There is considerable potential in use predictive analytical approaches in relation to the example of ILI, as the data sets considered, for example, weekly average temperature, Health Direct calls and paediatric respiratory viral presentations at EDs exhibited close inter relationships.
- As there are marked and dramatic variations in ILI indicators over short term frames, predictive methodologies potentially could underpin effective management of hospital resources.

1. Introduction

The project involves the use of a limited license of Forecast Pro XE to determine its utility to undertake a variety of modelling scenarios involving summarised time series data. A constraint of the license was a limit to 100 rows to analyse data in Excel and other data sources, though the number of columns was unlimited.

Note: Forecast Pro is available in three versions – Forecast Pro XE (ie the base limited version), Forecast Pro TRAC and Forecast Pro Unlimited.

The project involved analysis of two different sets of data: a suite of selected PMR measures and selected variables related to seasonal outbreaks of influenza like illness (ILI) in WA.

These two different areas were selected as to undertake a closer consideration of a range of issues. For example, in relation to the ILI data, the measures involved extended time series data with different time frames and that different intervals were used across different data series, for example, daily values (Bureau of Meteorology data), whereas values were for weekly or monthly intervals. Compared to the ILI data sets, the PMR data contained limited times series data (from July 2011) but that uniform time frames were used across data series and data was on a monthly basis.

A total of seven ILI measures were selected for inclusion:

- Respiratory viral presentations at emergency departments (recorded by EDSS)
- Influenza notifications (recorded by the Department of Health)
- Influenza positive tests (recorded by PathWest QE II)
- Google Flu Trends
- Australian Bureau of Meteorology maximum temperature
- Healthdirect Australia flu related data

A total of seven PMR measures were selected for inclusion:

- EA1 – Proportion (%) of emergency department patients seen within recommended times.
- EA2 – NEAT proportion of ED attendances with a LOE of less than or equal to 4 hours.
- EA3 – Mean overdue wait time of elective surgery cases waiting beyond the clinically recommended time.
- EA4 – Proportion of elective surgery patients treated within boundary times
- EA7 – Proportion of ED mental health patients admitted within 8 hours
- EA11 – Admissions from ED
- EQ10 – Rate of total hospital readmissions within 28 days to designated mental health inpatient unit.

This paper is specifically concerned with a review of the use of Forecast Pro involving the PMR measure EA1 the proportion of emergency department (ED) presentations seen with recommended times (EA1).

The data for EA1 was extracted from a 'cube' and exported as monthly counts at EDs broken down for each of the five triage categories, covering the period July 2011 to May 2014.

The restriction of analysis to indicator EA1 was justified as this indicator contained a relatively greater number of observations across the time period.

1.1 Overview

The project focussed on a number of issues which were identified as being of particular importance related to data quality, the capabilities of testing and the flexibility of reporting options contained in the program.

Data quality included investigation of limitations from the use of limited data points (ie the demand history), the capability of the program to make forecasts involving different types of data and the interface between the program and Excel.

Forecast Pro will accept three different data formats – spreadsheet, text and open database connectivity (ODBC). Examples of the latter types of ODBC relational databases include Microsoft Access, Oracle and SQL Server. The format of data for the exercise was concerned with the use of Excel, as this is widely used and provided the advantage of producing summarised sheets which are accessed by Forecast Pro, which have been constructed by linking subsidiary spreadsheets loaded with data imported from database queries.

Testing of the capabilities of Forecast Pro was concerned with how Forecast Pro analysed sets of test data and how it reported limitations of analyses of time series data such as missing cases, different time intervals (eg weekly, monthly, quarterly and annual data), the interaction between trends and variations arising from seasonality.

The testing and reporting component was concerned with the statistical modelling technique that was selected by Forecast Pro as the most appropriate for each scenario and this was reported. Whilst the user can select a particular scenario, as Forecast Pro includes a detailed printed description of the particular option the program has selected as a standard component of how it produces output and reports each time a forecasting scenario is performed. This suggests that the preferred approach should be to utilise the built-in reporting options, if these are documented and justified by the program.

It should be noted Forecast Pro provides the user with a selection of methodologies suitable for univariate analysis (eg time series data), as well as having the capability to undertake dynamic regression and multi level forecasting etc.

A feature of Forecast Pro is that it defaults to an “expert selection”, which means that the application has selected what it considers to be the optimal methodology, after taking into account factors such as the number of data points, seasonality patterns and variability of the data being analysed.

The selection of a forecasting option is constructed on the amount and quality of historical data in the variable on which the forecast is being undertaken, which is used by Forecast Pro to determine an appropriate methodology that is suitable for analysis of univariate data, such as, simple moving average, curve fitting, exponential smoothing and Box-Jenkins.

Because of the limitations of methodologies like simple moving average and curve fitting, which do not adequately measure the impact of seasonality and trends, Forecast Pro will use exponential smoothing because of the power of this approach to identify seasonality and to extrapolate from a time series to provide a projected set of points or adopt Box-Jenkins if there are high levels of correlation in the historic data being used.

Whilst the project has largely focussed up to this stage on the feasibility of using univariate methodologies in relation the PMR data sets, it should be noted that the application’s dynamic regression option is of interest in relation to second area of study related to modelling the impact of ILI on the public hospital system.

The second study concerned with modelling of a number of ILI-related variables, involved dynamic modelling to examine relationships between a dependent variable, such as the number of presentations of persons with ILI symptoms at EDs and an independent (explanatory) variable, such as minimum daily average temperature. Other examples of dependent variables could be daily mean maximum temperatures, or counts of self reports of ILI recorded by Google Flu or other social media.

1.2 Terms

Some of the terms the Forecast Pro automatically includes in reports generated by the application require some explanation, as they are presented as acronyms.

The concept of “fitted values” refers the approach whereby a set of known values may be analysed to represent that data in a form of an equation or to use a known set of data to predict future values. These may also referred to as “predicted values”.

The application operates in automated manner, or the user may make a manual selection, to apply an equation to the known data generate a graph of which includes or approximates a majority of data points in a given data set. The graphs include a plot of fitted values which have been generated by extending the model past known data points in order to predict unknown values. Graphs may be customised by the user, to toggle off whether to display a plot of confidence intervals.

For example, MAPE and MAD, which are concerned with the accuracy that exists for a particular out of the sample forecast, refer to Mean absolute percent error (MAPE) and Mean absolute deviation (MAD), respectively.

A mean absolute deviation score is also known as the mean absolute error score and used to quantify how close a forecast is to an eventual outcome.

As a MAD score is derived from interval data and because the value expressed in this score is proportional to the scale of the variable, a MAD value it should not ordinarily be compared with a MAD value for another variable. This means that MAD scores are an appropriate measure when comparing different forecast methods for the same variable (ie time series data).

Whereas MAD scores are a valid measure to determine the significance of an analysis of interval type of data, as MAPE scores are only valid for ratio scale type of data, MAPE score can be compared for different values. As the computation of a MAPE score involves by dividing forecast errors by the actual values by taking absolute values and averaging, this means it can only be used to analyse positive data with a non-arbitrary or real zero point.

1.3 Reporting

A number of examples of how Forecast Pro reports are reproduced below, which demonstrate how the formats of report utilises a naturalistic conversation-like approach in how it results are presented and explained.

Example 1: Short data series

Expert analysis

Using rule-based logic I have narrowed down the choice to exponential smoothing or Box-Jenkins.

Series is too short to consider Box-Jenkins.

I will use Exponential Smoothing.

Within sample statistics

Sample size	24	No. parameters	1
Mean	0.94	Std. deviation	0.02
R-square	0.00	Adj. R-square	0.00
Durbin-Watson	2.10	Ljung-Box(18)	16.8 P=0.46
Forecast error	0.02	BIC	0.02
MAPE	1.87%	SMAPE	1.86%
RMSE	0.02	MAD	0.02
MAD/Mean Ratio	0.02		

Example 2: Short data series - PMR indicator EA4 (total per cent)

Expert analysis

Using rule-based logic I have narrowed down the choice to exponential smoothing or Box-Jenkins.

Series is too short to consider Box-Jenkins.

I will use Exponential Smoothing.

Model details

Exponential smoothing:

No trend,

Additive seasonality

NA(0.793, 1.000)

Component Smoothing Wgt

Final Value

Level 0.7926 0.9151

Seasonal 0.9999

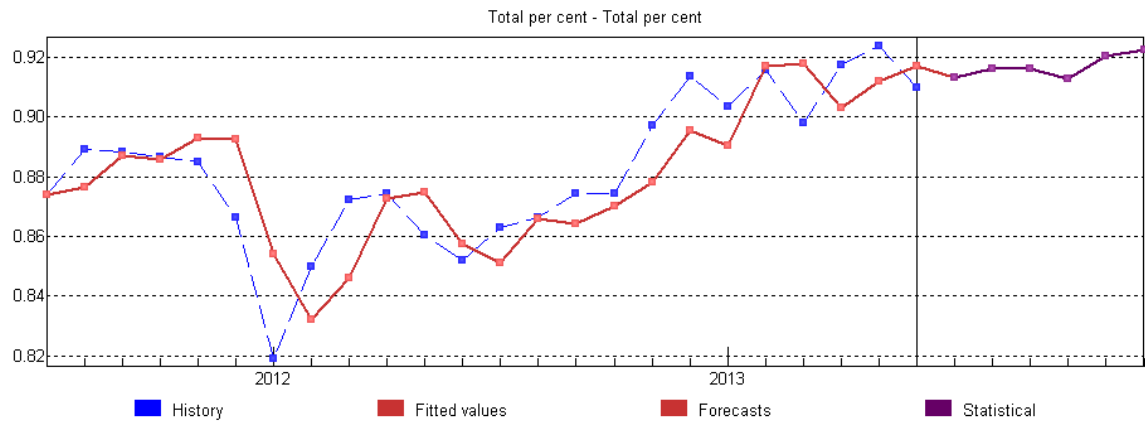
Within sample statistics

Sample size	24	No. parameters	2
Mean	0.88	Std. deviation	0.03
R-square	0.64	Adj. R-square	0.62
Durbin-Watson	1.41	Ljung-Box(17)	20.7 P=0.76
Forecast error	0.02	BIC	0.02
MAPE	1.33%	SMAPE	1.33%
RMSE	0.01	MAD	0.01
MAD/Mean Ratio	0.01		

Graphical output

After the program has undertaken analysis of set of data, output is reported as a graph in addition to a number of reports, as described above.

This is an example of modelling of time series data (July 2012 to May 2013) which is presented as historical data and fitted values, with a further six months of forecasted values.



Example 3: Long data series – Total ILI presentations at ED

Expert analysis

Using rule-based logic I have narrowed down the choice to exponential smoothing or Box-Jenkins.

I will perform an out-of-sample test to select between these two approaches.

The cumulative MAD for Exponential smoothing was 6.43 and for Box-Jenkins was 6.08.

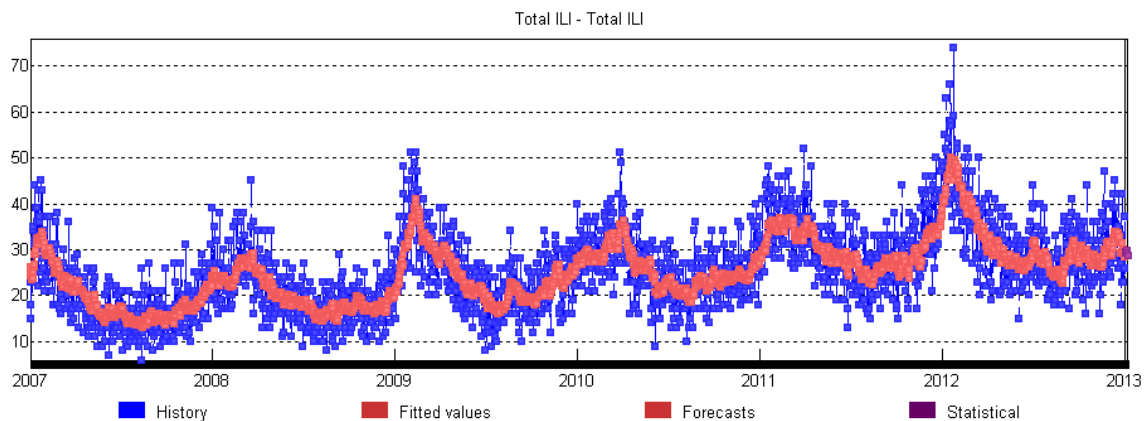
The rolling out-of-sample test used a maximum horizon of 12 and generated 78 forecasts for each method.

Based on the lower MAD, I will use Box-Jenkins.

Within sample statistics

Sample size 2,192
 No. parameters 4
 Mean 7.92
 Std. deviation 1.72
 R-square 0.58
 Adj. R-square 0.58
 Durbin-Watson 1.92
 Ljung-Box(18) 49.2 P=1.00
 Forecast error 1.12
 BIC 5.48
 MAPE 19.23%
 SMAPE 18.24%
 RMSE 5.66
 MAD 4.46
 MAD/Mean Ratio 0.18

Graphical output



Example 4: Long data series – GFT (2009 – 2013)

Expert analysis

Using rule-based logic I have narrowed down the choice to exponential smoothing or Box-Jenkins. I will perform an out-of-sample test to select between these two approaches. The cumulative MAD for Exponential smoothing was 135.56 and for Box-Jenkins was 136.77. The rolling out-of-sample test used a maximum horizon of 12 and generated 78 forecasts for each method.

Based on the lower MAD, I will use Exponential Smoothing.

Model details

Expert selection

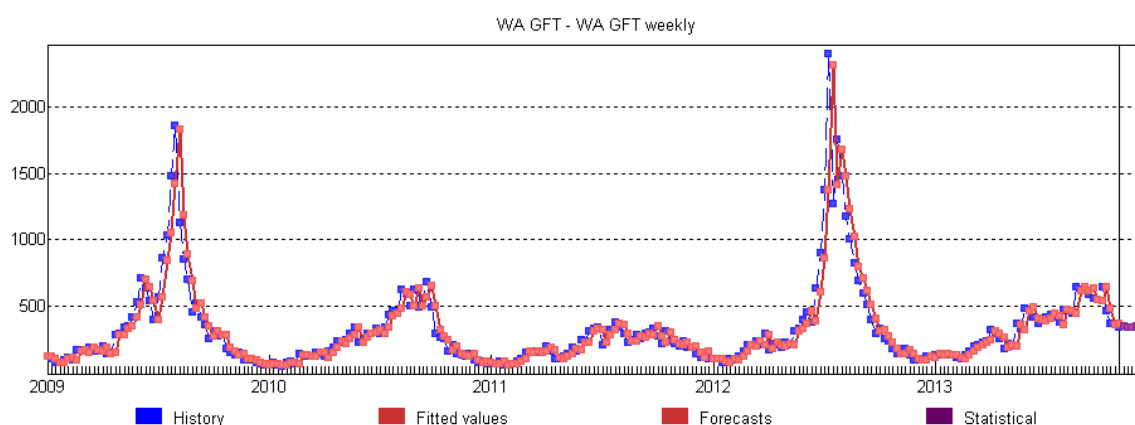
Exponential smoothing: No trend, Multiplicative seasonality
NM(0.921, 0.245)

Confidence limits proportional to indexes and level

Within sample statistics

Sample size	252
No. parameters	2
Mean	314.17
Std. deviation	310.61
R-square	0.79
Adj. R-square	0.79
Durbin-Watson	2.05
Ljung-Box(18)	14.1 P=0.28
Forecast error	141.08
BIC	143.64
MAPE	19.45%
SMAPE	19.03%
RMSE	140.52
MAD	68.60
MAD/Mean Ratio	0.22

Graphical output



2. ILI forecasting

2.1 Overview

There is a well established system of public health system reporting throughout Australia and in WA, as in other jurisdictions, this includes a variety of monitoring and reporting systems which have been developed to track seasonal outbreaks of a range of ILI illnesses, to track a spectrum of indicators, such as ranging from presentations at general practitioners to more serious illnesses involving presentations at emergency departments at paediatric and adult hospitals.

An appreciation of the range of data systems that could be utilised to predict outbreaks can be seen in the following monitoring systems, which means as each have different levels of coverage, it is necessary to utilise multiple measures to infer the emergence and impact of ILI outbreaks.

2.2 National surveillance systems

Six components of the national surveillance system were considered:

- National Notifiable Diseases Surveillance System (NNDSS) (consists of laboratory confirmed cases)
- General practitioner consultations for influenza-like illness
- Emergency department presentations for influenza-like illness
- Call centre calls related to influenza-like illness
- Community level surveys
- Sentinel laboratory test results

National Notifiable Diseases Surveillance System¹

The National Notifiable Diseases Surveillance System (NNDSS) was established in 1990 under the auspices of the Communicable Disease Network Australia. Its purpose is to coordinate the national surveillance on an agreed list of communicable diseases or disease groups in Australia and has published annual reports since 1991.

The following history of the surveillance of notifiable diseases is from the Department of Health Ageing website.²

¹ <http://www.health.gov.au/internet/main/publishing.nsf/content/cda-surveil-nndss-nndssintro.htm>

² http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-surv_sys.htm#nndss

“National compilations of notifiable diseases have been published intermittently in a number of publications since 1917. The National Notifiable Diseases Surveillance System (NNDSS) was established in 1990 under the auspices of the Communicable Diseases Network Australia (CDNA).

Sixty-five communicable diseases agreed upon nationally are reported to NNDSS, although not all 65 are notifiable in each jurisdiction. Data are sent electronically from states and territories daily or several times a week. The system is complemented by other surveillance systems, which provide information on various diseases, including four that are not reported to NNDSS (AIDS, HIV, and the classical and variant forms of Creutzfeldt-Jakob disease).

The NNDSS core dataset includes data fields for a unique record reference number; notifying state or territory; disease code; age; sex; Indigenous status; postcode of residence; date of onset of the disease; death, date of report to the state or territory health department and outbreak reference (to identify cases linked to an outbreak). Where relevant, information on the species, serogroups/subtypes and phage types of organisms isolated, and on the vaccination status of the case is collected. Data quality is monitored by DoHA and the National Surveillance Committee (NSC) and there is a continual process of improving the national consistency of communicable disease surveillance.

While not included in the core national dataset, enhanced surveillance information for some diseases (hepatitis B [newly acquired], hepatitis C [newly acquired], invasive pneumococcal disease and tuberculosis) is obtained from states and territories.”

Australian influenza surveillance report

Published by: Department of Health and Ageing

National Health Call Centre Network

<http://www.health.gov.au/internet/main/publishing.nsf/Content/national-health-call-centre-network-team-overview>

The creation of a National Health Call Centre Network (NHCCN) was the result of decision announced in February 2006 by the Council of Australian Governments. The NHCCN commenced delivering services in July 2007 under a single national name, Healthdirect Australia. It operates as a national phone number (1800 022 222).

Services are currently being delivered to the Australian Capital Territory, Northern Territory, South Australia, Western Australia, New South Wales and Tasmania. The service is staffed by registered nurses, supported by electronic decision support software and algorithms, to provide safe and effective health triage, information and advice to callers. It has an online capability and the capacity to support add-on services and to assist in health threats and emergency situations.

The Australian Government and the governments of the Australian Capital Territory, New South Wales, Northern Territory, South Australia, Tasmania and Western Australia have established National Health Call Centre Network Ltd (the Company). It is a private company limited by shares, which is responsible for contracting with service providers for the call centre's services and managing the Network's operations.

Queensland and Victoria have signalled an intent to join, but are yet to commit formally to the Network.³

³ Adapted from <http://www.health.gov.au/internet/main/publishing.nsf/Content/national-health-call-centre-network-team-overview>

FluTracking

<http://www.flutracking.net/index.html>

An online health surveillance to detect and monitor influenza epidemics in Australia through obtained from a weekly online survey. It is a project of the University of Newcastle, the Hunter New England Area Health Service and the Hunter Medical Research Institute.

Influenza complications alert network (FluCAN)

Sentinel hospital surveillance system

Sentinel general practice surveillance

<https://www.victorianflusurveillance.com.au/>

This surveillance system is based on data obtained from two GP schemes – the Australian Sentinel Practices Research Network (ASPREN) and a Victorian infectious disease reference laboratory (VIDRL) which operates in metropolitan and rural GP sentinel sites in Victoria.

The ASPREN scheme has sentinel by GPs in NSW, NT, SA, ACT, VIC, QLD, TAS and WA, who report on ILI presentations throughout the year.

Website: <https://www.dmac.adelaide.edu.au/aspreen/>

The (VIDRL) which operates in metropolitan and rural GP sentinel sites in Victoria and obtains data between May and October each year.

2.3 WA State surveillance systems

Virus watch report

http://www.public.health.wa.gov.au/3/487/2/virus_watch_homepage.pm

Virus watch is published weekly by the Communicable Disease Control Directorate of the Health Department of WA. Its purpose is to provide summarised sentinel data obtained from general practice and hospital emergency departments concerned with a number of communicable diseases, including presentations involving influenza-like illness.

In addition to general practice data obtained by the Sentinel Practitioners Network of WA (SPNWA), the virus watch report includes emergency department presentations recorded by the Emergency Department Information System (EDIS), results from viral laboratory data analysed by PathWest from the QE II Medical Centre and Princess Margaret Hospital and notifications data sent to the Communicable Disease Control Directorate from all laboratories in WA.

Prior to June 2009 the data contained in Virus watch was published in Virus News and Emergency Department Sentinel Surveillance News.

Sentinel practitioners network of WA

Website:

http://www.public.health.wa.gov.au/3/493/2/sentinel_practitioners_network_of_western_aust_rali.pm

This system is intended to collect information about vaccine preventable viruses, such as varicella, influenza and rotavirus, involving GPs located in metropolitan, country, rural and remote areas, who submit weekly data to the Australian Sentinel Practices Research Network, of

the number of patients seen with and tested for influenza-like illnesses, gastroenteritis, chickenpox and shingles.

Princess Margaret Hospital respiratory pathogen report

Website: http://www.public.health.wa.gov.au/3/494/2/pmh_respiratory_pathogen_reports.pm

This weekly report is compiled by the Department of Virology at PathWest and has been published since July 2007.

Health Direct

This service was established by the Department of Health in 1999 and was operated as a State level service until it joined Healthdirect Australia in July 2007. Data is available from 2002 is largely for monthly counts of activity, with weekly data available from about 2006, with a daily feed provided to the State from the NHCCN system from July 2007.

3. PMR forecasting

3.1 Key points

Emergency department (ED) data was used to model forecasting of trends according to recommended times by triage category and hospital

Triage category

The ED system categorises each presentation into one of five discrete categories:

- Category 1 – Seen within 2 minutes
- Category 2 – Seen within 10 minutes
- Category 3 – Seen within 30 minutes
- Category 4 – Seen within 60 minutes
- Category 5 – Seen within 2 hours

Hospitals

The project considered data from 14 hospitals – the five teaching hospitals (ie Sir Charles Gairdner Hospital, Royal Perth Hospital, Fremantle Hospital, Princess Margaret Hospital and King Edward Hospital), three other major metropolitan satellite hospitals (ie Swan Districts, Armadale-Kelmscott and Rockingham hospitals) and six regional (non-metropolitan) hospitals (ie Albany, Broome, Bunbury, Geraldton, Hedland and Kalgoorlie hospitals)

- Sir Charles Gairdner Hospital
- Royal Perth Hospital
- Fremantle Hospital
- Princess Margaret Hospital
- King Edward Memorial Hospital
- Swan Districts Hospital
- Armadale-Kelmscott Hospital
- Rockingham Hospital
- Albany Hospital
- Broome Hospital
- Bunbury Hospital
- Geraldton Hospital
- Hedland Hospital
- Kalgoorlie Hospital

3.2 Overview

As analysis of the EA1 time series data for each hospital was broken down by triage category and exported into a series of separate workbook for each measure.

The existence of a specific worksheet for each workbook and for a specific indicator, was necessary to ensure that Forecast Pro would analyse time series data for the indicator in a reliable and efficient manner, in accordance with the suggestion in the Forecast Pro manual –

‘You may either devote an entire worksheet to the data (recommended) or specify a portion of a worksheet by giving it the range name BFSDATA. In a multi worksheet workbook the data is assumed to reside in the first (topmost) worksheet unless an alternate sheet has been specified by naming it BFSDATA.’⁴

3.3 Data source

A series of linked “cube” pivots were set up, formatted as separate worksheets, to capture output for “Numerator” and “Denominator” values and to preserve the data generated by each pivot, so as to identify the parameters and scope of the data being queried.

The first (topmost) worksheet in each workbook was established to calculate the monthly values for each hospital, based on linked cells drawing values from both the numerator and denominator worksheets.

The link to the “Data cube” for data up to June 2013 was –

Provider=MSOLAP.4;Integrated Security=SSPI; Persist Security Info=True; Initial Catalog=MIS_ABFM_12_13_Cubes;Data Source=wsfm743sql;MDX Compatibility=1;Safety Options=2;MDX Missing Member Mode=Error

The link to the “Data cube” for data up to June 2014 was –

Provider=MSOLAP.4;Integrated Security=SSPI; Persist Security Info=True; Initial Catalog=MIS_ABFM_13_14_Cubes;Data Source=wsfm743sql;MDX Compatibility=1;Safety Options=2;MDX Missing Member Mode=Error

Data in the pivots generated by the cube was copied and pasted data as values (ie not linked) into separate worksheets for numerator and denominator values, which are linked to a third worksheet to calculate the proportion of cases for each row. The three sets of worksheets are named –

- cube data numerator
- cube data denominator
- proportions

3.4 Data coverage

The cube data was interrogated and exported for up to each of the 14 hospitals, depending on data availability, as follows:

- Sir Charles Gairdner Hospital

⁴ Stellwagen EA & Goodrich RL. *Forecast Pro XE user's guide*. Belmont, MA, Business Forecast Systems, 2011, 120.

- Royal Perth Hospital
- Fremantle Hospital
- Princess Margaret Hospital
- King Edward Memorial Hospital
- Swan Districts Hospital
- Armadale-Kelmscott Hospital
- Rockingham Hospital
- Albany Hospital
- Broome Hospital
- Bunbury Hospital
- Geraldton Hospital
- Hedland Hospital
- Kalgoorlie Hospital

In addition to these selected 14 hospitals, the aggregate total of these hospitals, reported as “Total hospitals”, was computed as an extra row, which resulted in a data set that consisted of 15 rows.

3.5 Triage categories

The five triage categories (as defined in the data cube) were:

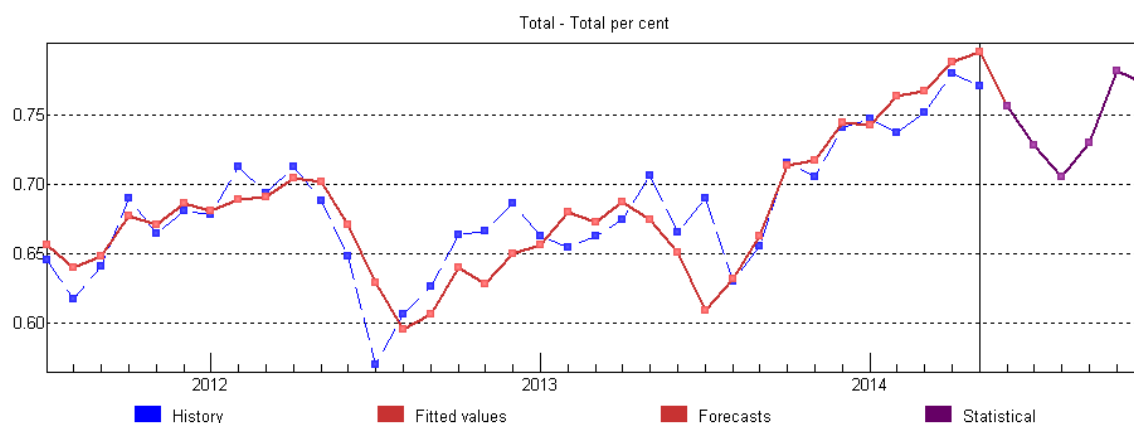
- Category 1 – Seen within 2 minutes (eg EA1A)
- Category 2 – Seen within 10 minutes (eg EA1B)
- Category 3 – Seen within 30 minutes (eg EA1C)
- Category 4 – Seen within 60 minutes (eg EA1D)
- Category 5 – Seen within 2 hours (eg EA1E)

Appendix 1: PMR measure EA1

Indicator EA1: Hospital - total triage categories

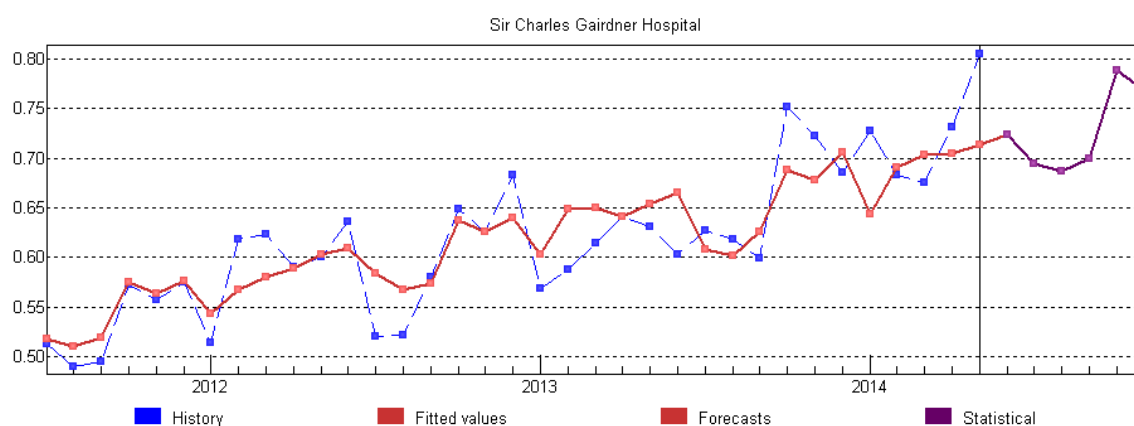
Total hospitals

Figure 1-1: Total hospitals, July 2011 - November 2014: EA1



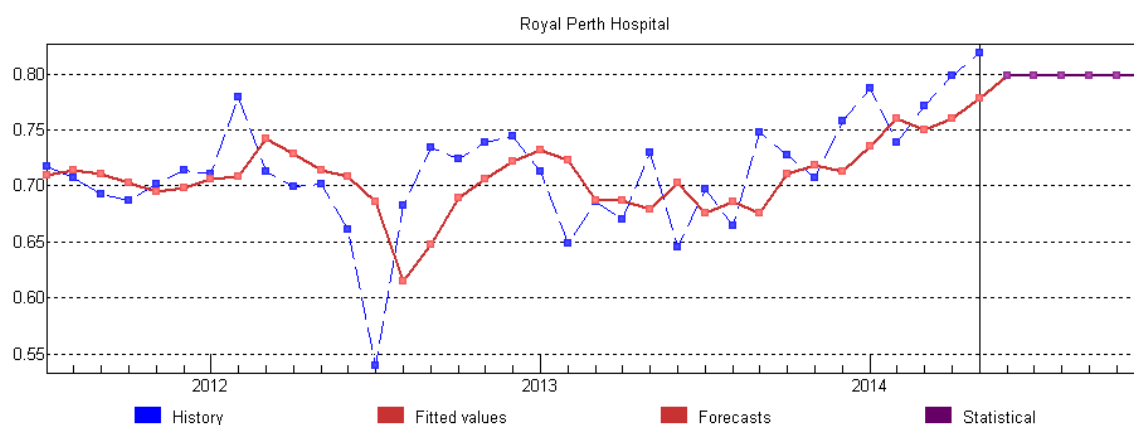
Sir Charles Gairdner Hospital

Figure 1-2: SCGH, July 2011 - November 2014: EA1



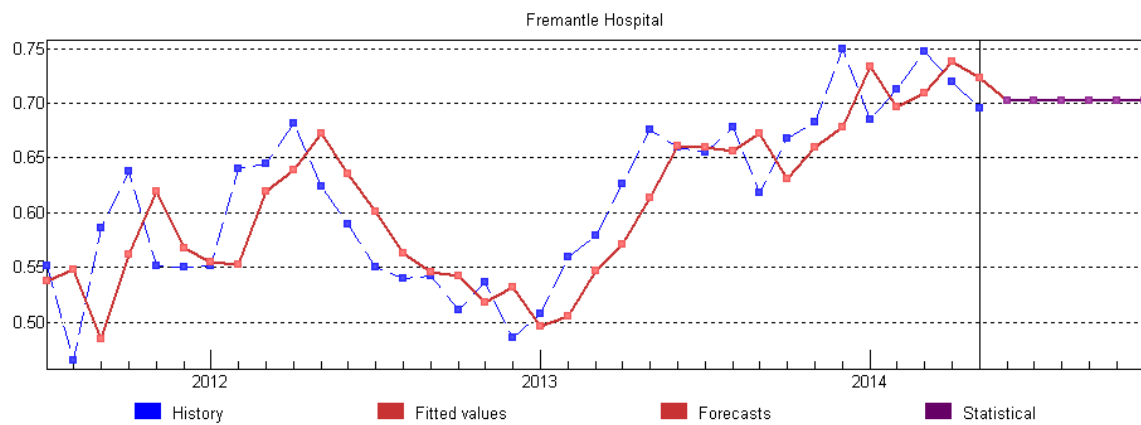
Royal Perth Hospital

Figure 1-3: RPH, July 2011 - November 2014: EA1



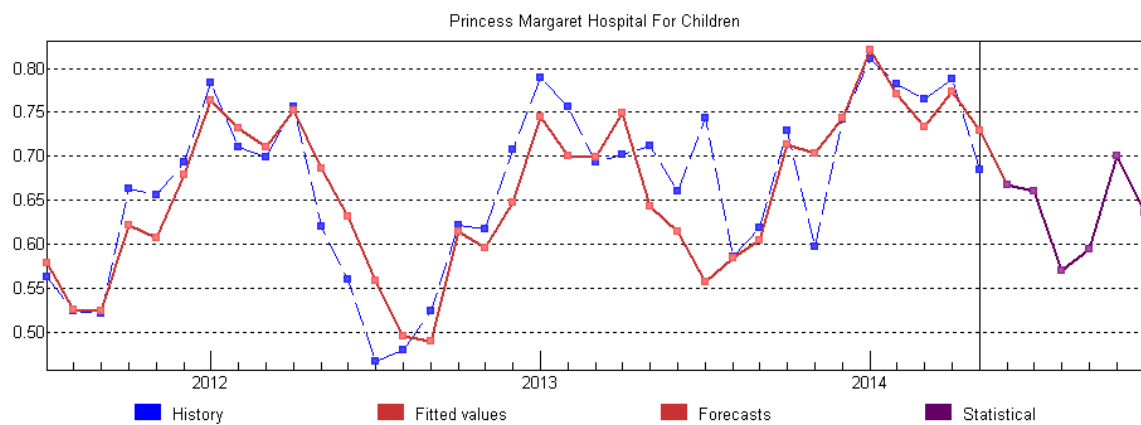
Fremantle Hospital

Figure 1-4: FH, July 2011 - November 2014: EA1



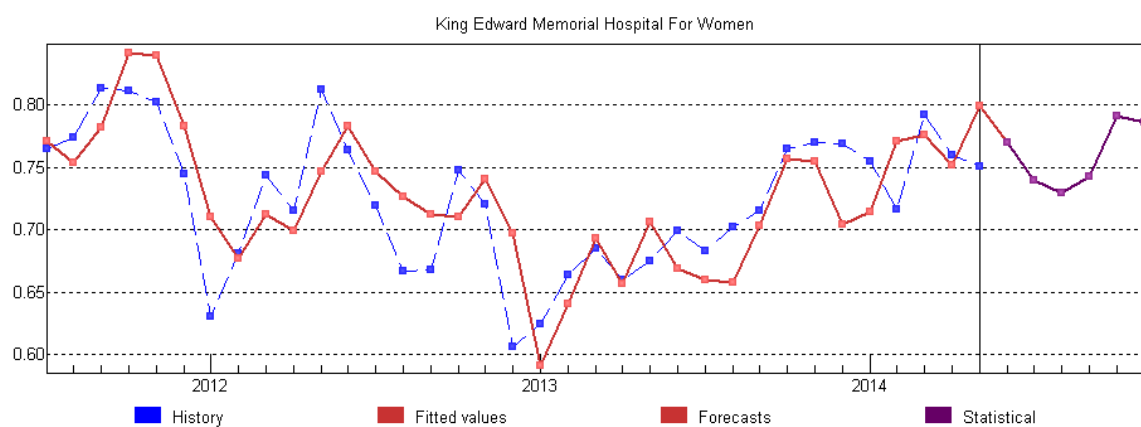
Princess Margaret Hospital

Figure 1-5: PMH, July 2011 - November 2014: EA1



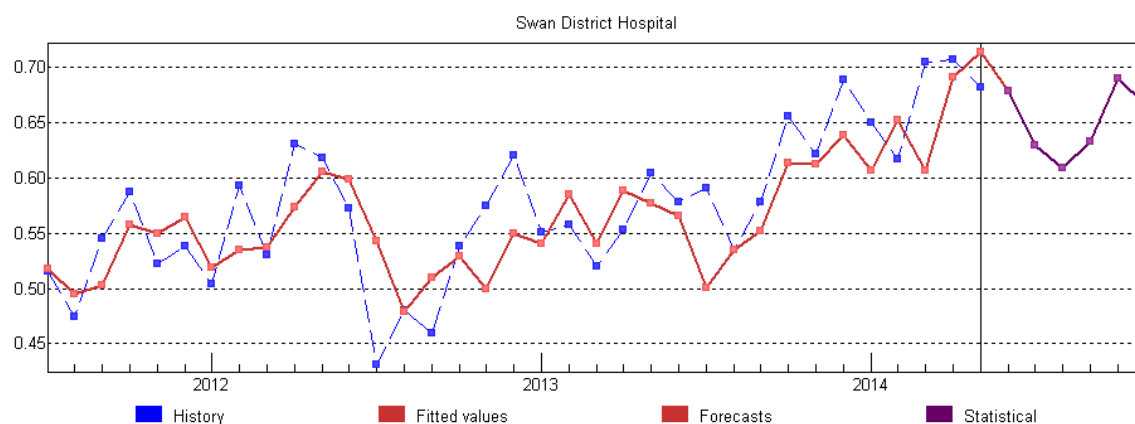
King Edward Memorial Hospital

Figure 1-6: KEMH, July 2011 - November 2014: EA1



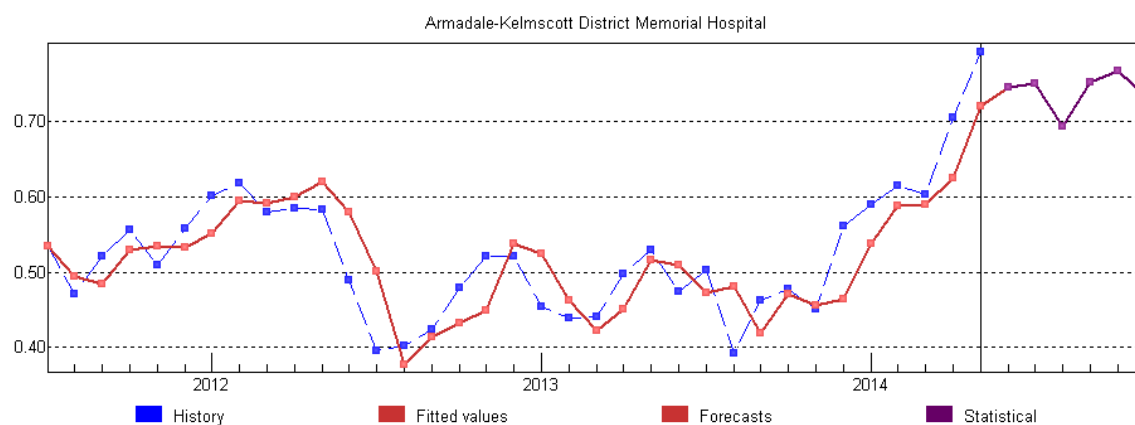
Swan Districts Hospital

Figure 1-7: Swan Districts Hospital, July 2011 - November 2014: EA1



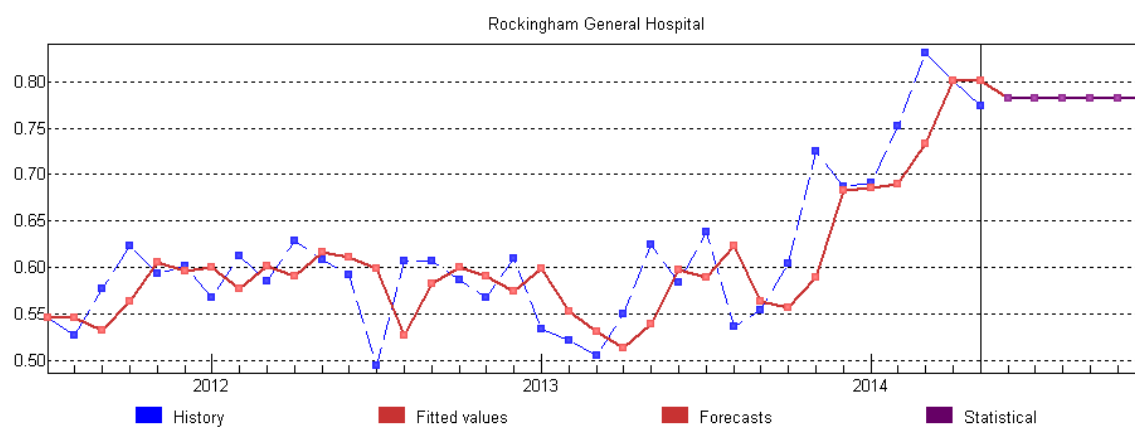
Armadale Kelmscott Hospital

Figure 1-8: Armadale Kelmscott Hospital, July 2011 - November 2014: EA1



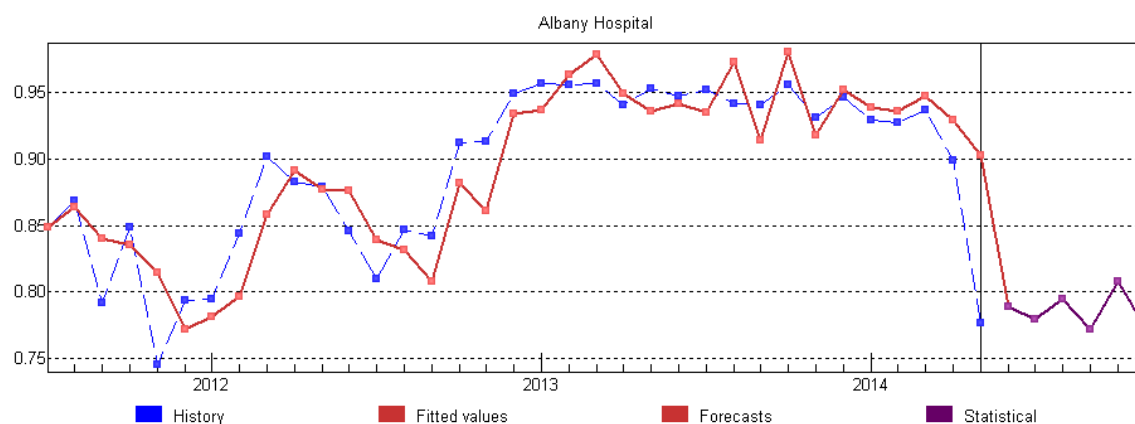
Rockingham Hospital

Figure 1-9: Rockingham Hospital, July 2011 - November 2014: EA1



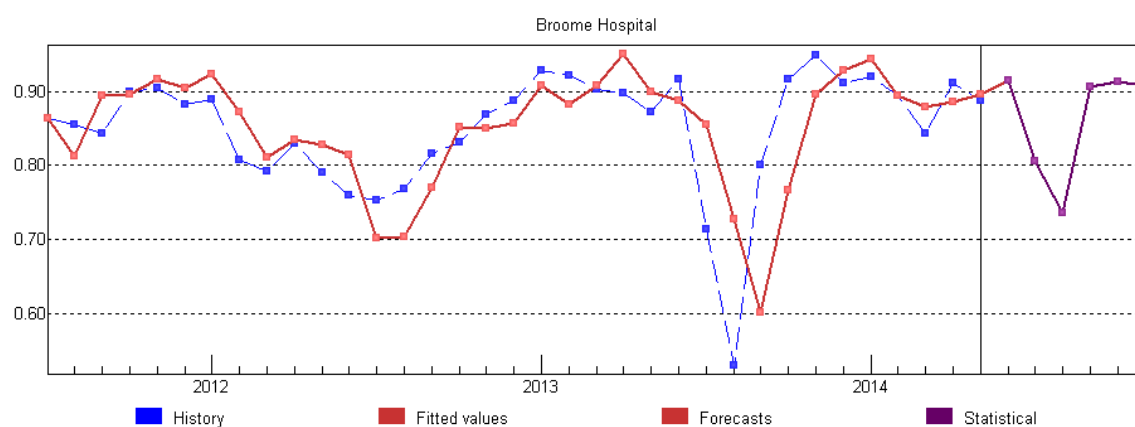
Albany Hospital

Figure 1-10: Albany Hospital, July 2011 - November 2014: EA1



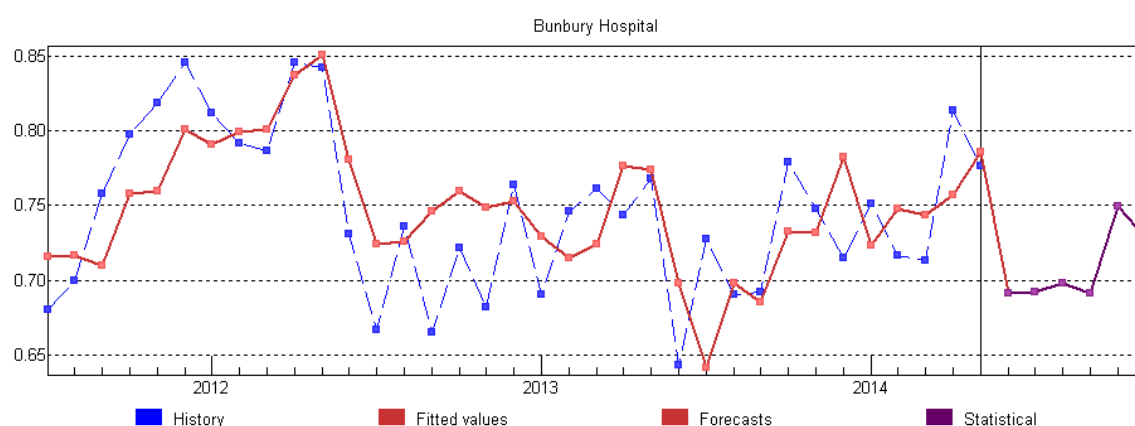
Broome Hospital

Figure 1-11: Broome Hospital, July 2011 - November 2014: EA1



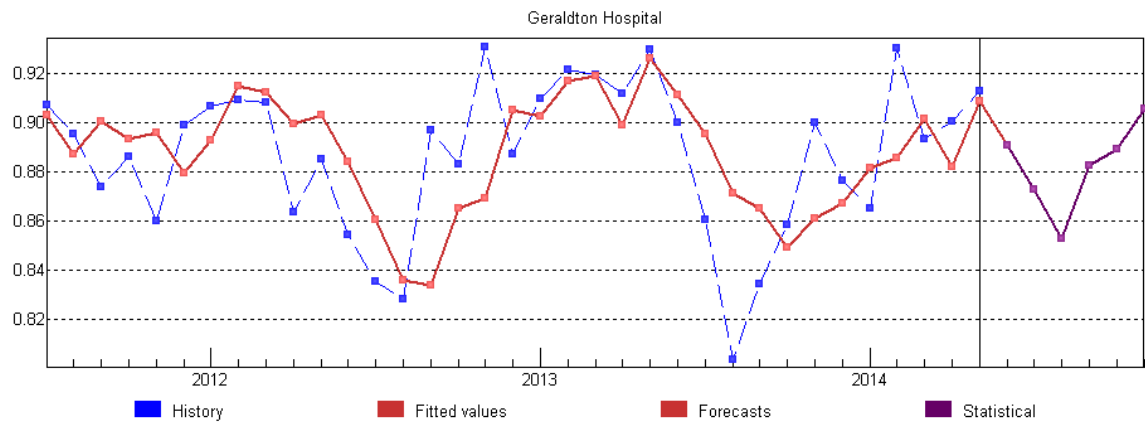
Bunbury Hospital

Figure 1-12: Bunbury Hospital, July 2011 - November 2014: EA1



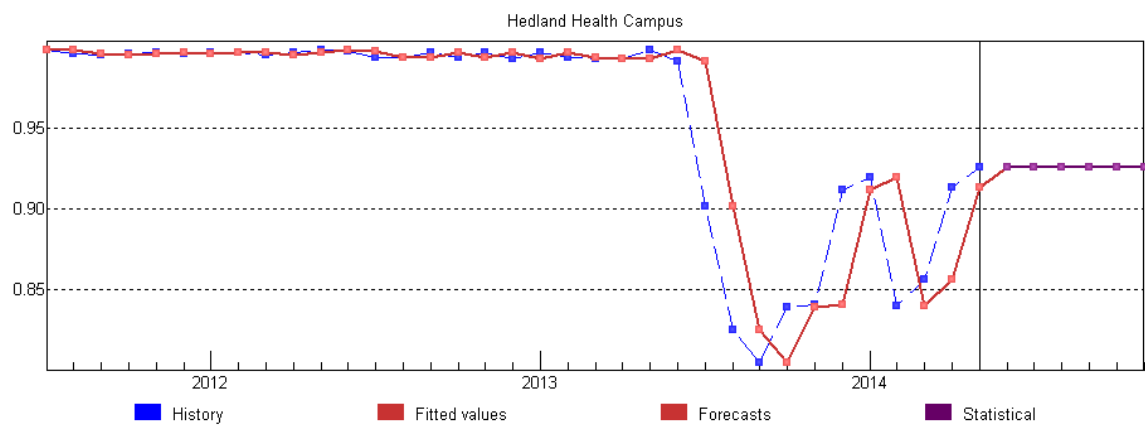
Geraldton Hospital

Figure 1-13: Geraldton Hospital, July 2011 - November 2014: EA1



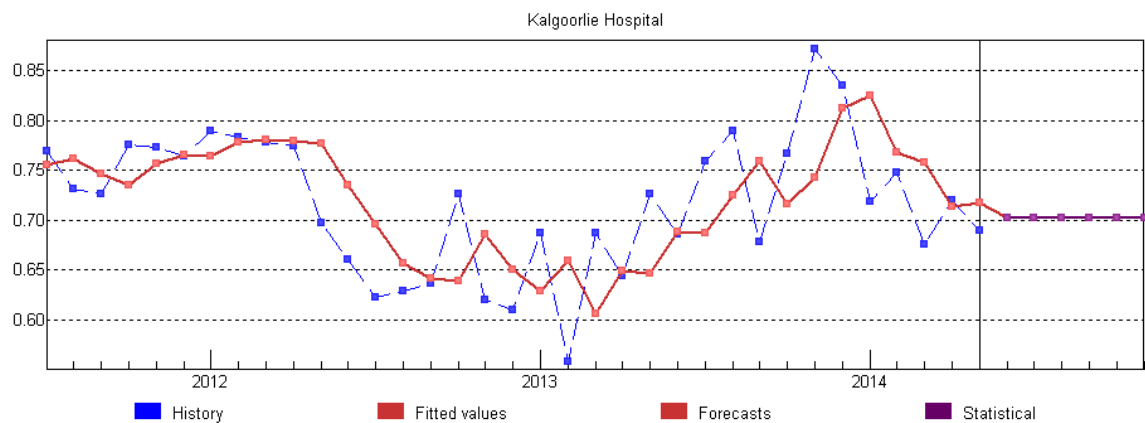
Hedland Hospital

Figure 1-14: Hedland Hospital, July 2011 - November 2014: EA1



Kalgoorlie Hospital

Figure 1-15: Kalgoorlie Hospital, July 2011 - November 2014: EA1

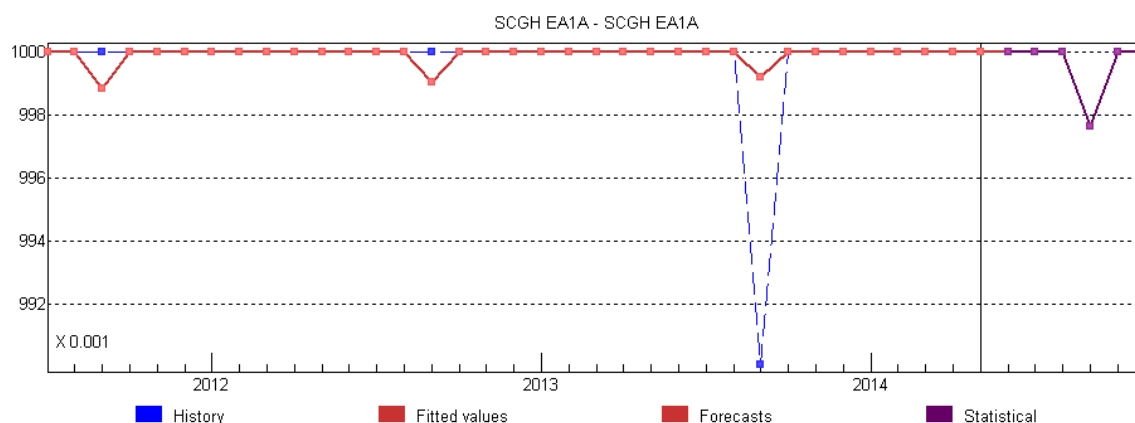


Appendix 2: PMR measure EA1 – Triage sub category 1

Indicator EA1: Hospital - triage sub-category (seen within 2 minutes)

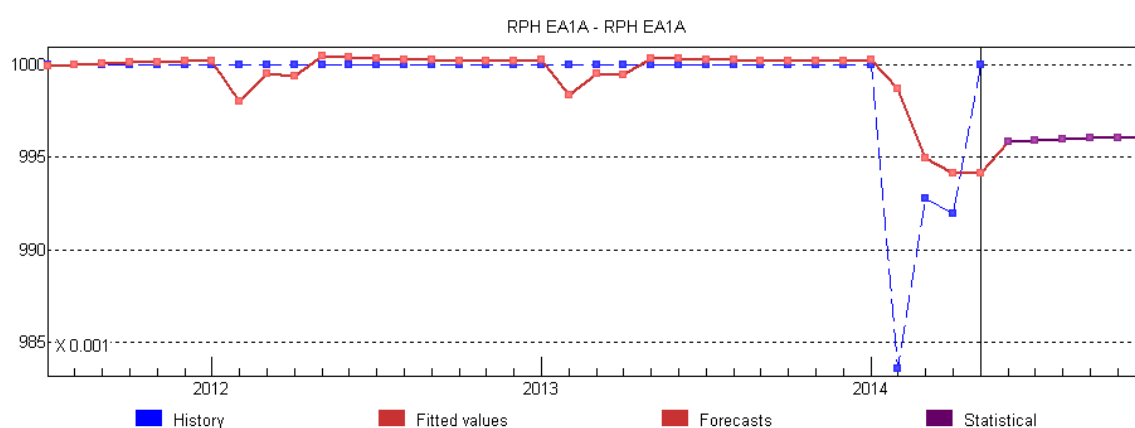
Sir Charles Gardiner Hospital

Figure 2-1: SCGH, July 2011 - November 2014: EA1A



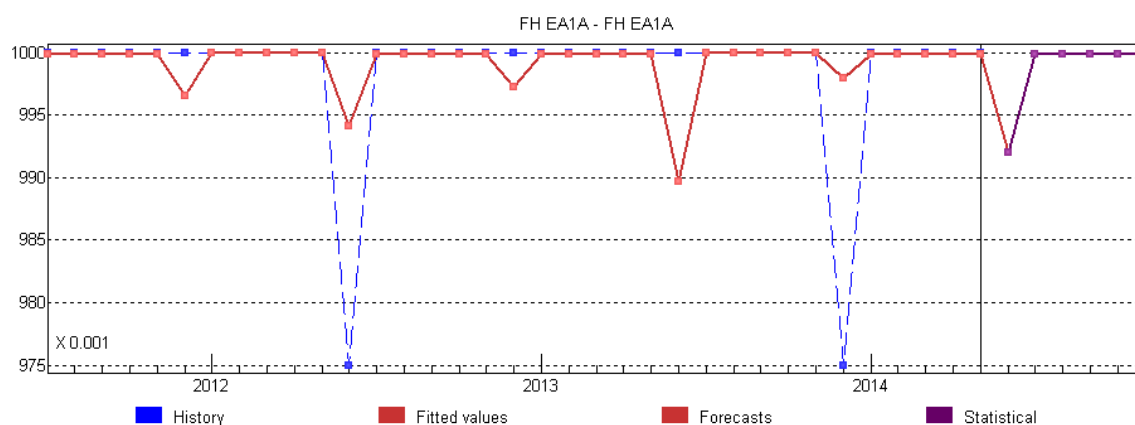
Royal Perth Hospital

Figure 2-2: RPH, July 2011 - November 2014: EA1A



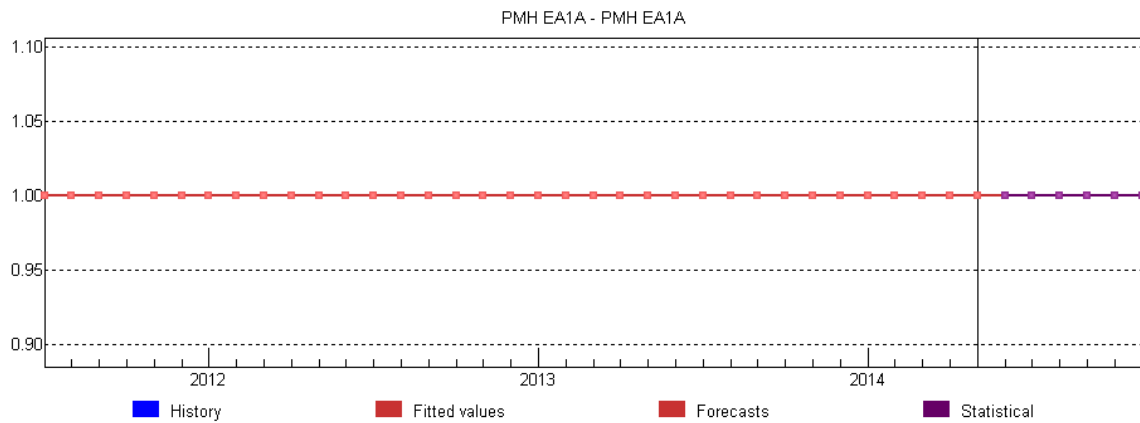
Fremantle Hospital

Figure 2-3: FH, July 2011 - November 2014: EA1A



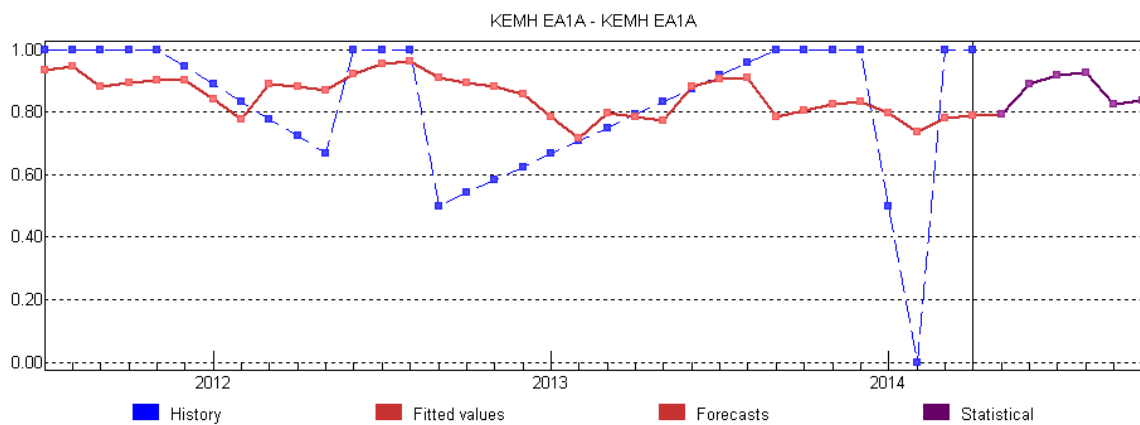
Princess Margaret Hospital

Figure 2-4: PMH, July 2011 - November 2014: EA1A



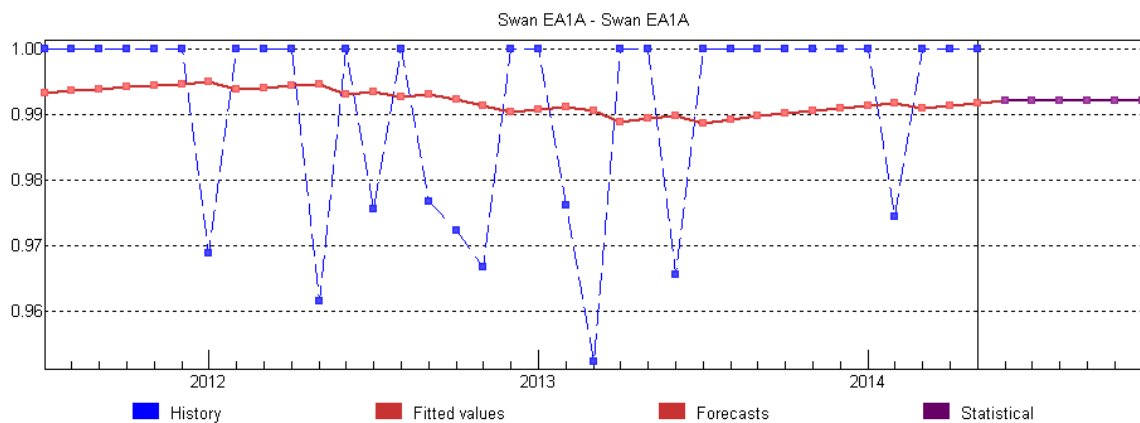
King Edward Memorial Hospital

Figure 2-5: KEMH, July 2011 - November 2014: EA1A



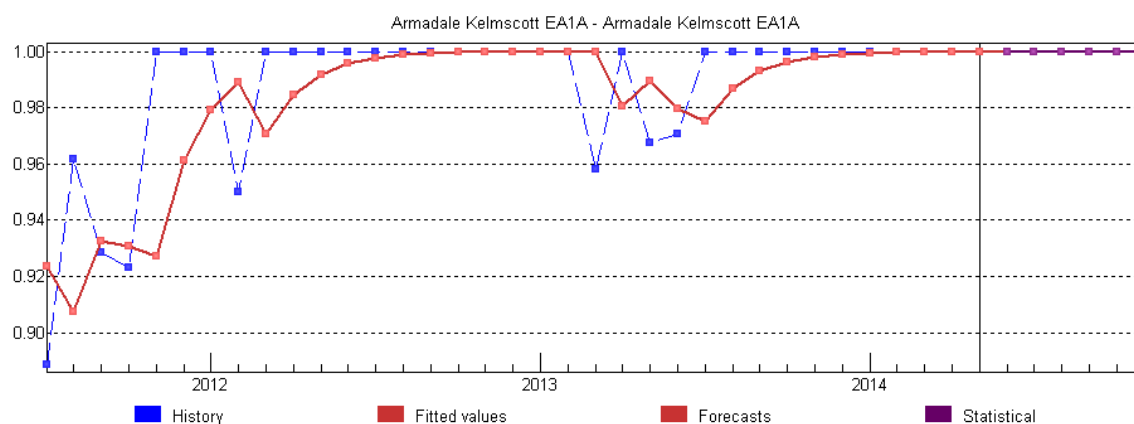
Swan Districts Hospital

Figure 2-6: Swan Districts, July 2011 - November 2014: EA1A



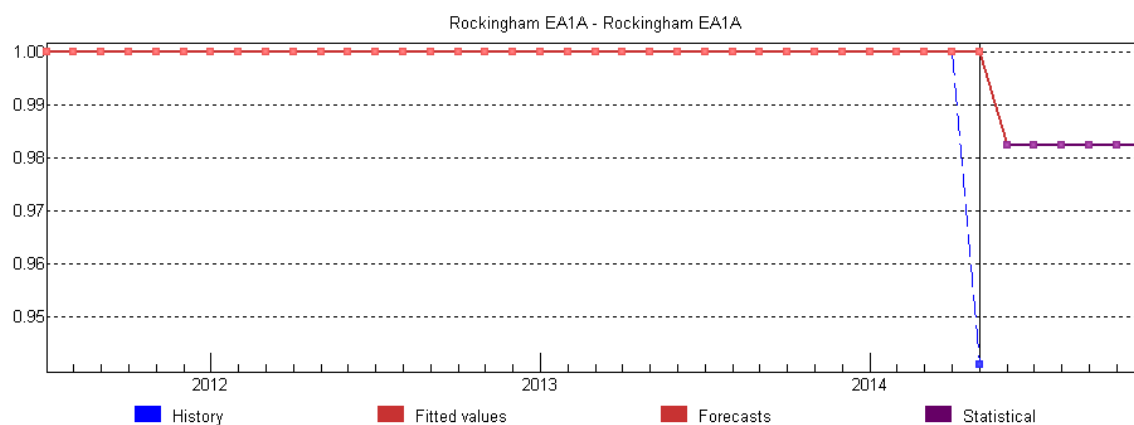
Armada-Kelmscott Hospital

Figure 2-7: Armada-Kelmscott, July 2011 - November 2014: EA1A



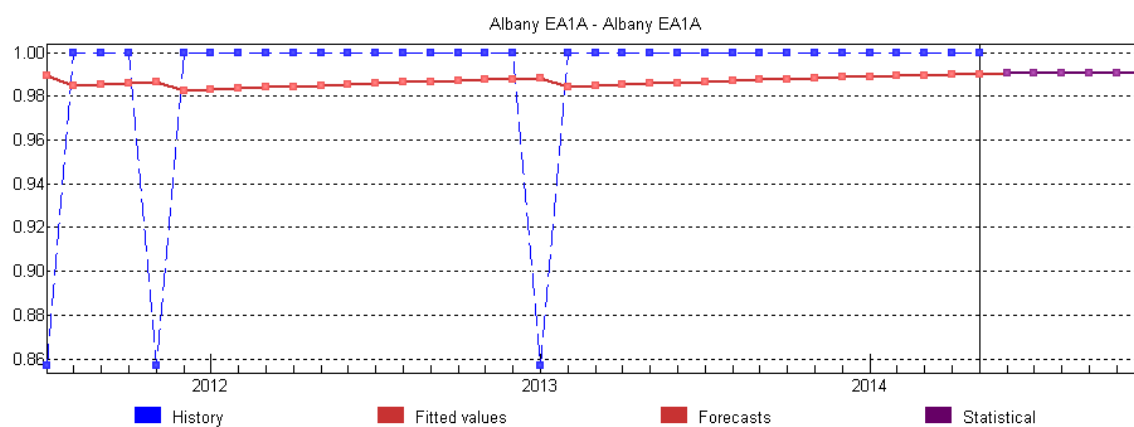
Rockingham Hospital

Figure 2-8: Rockingham Hospital, July 2011 - November 2014: EA1A



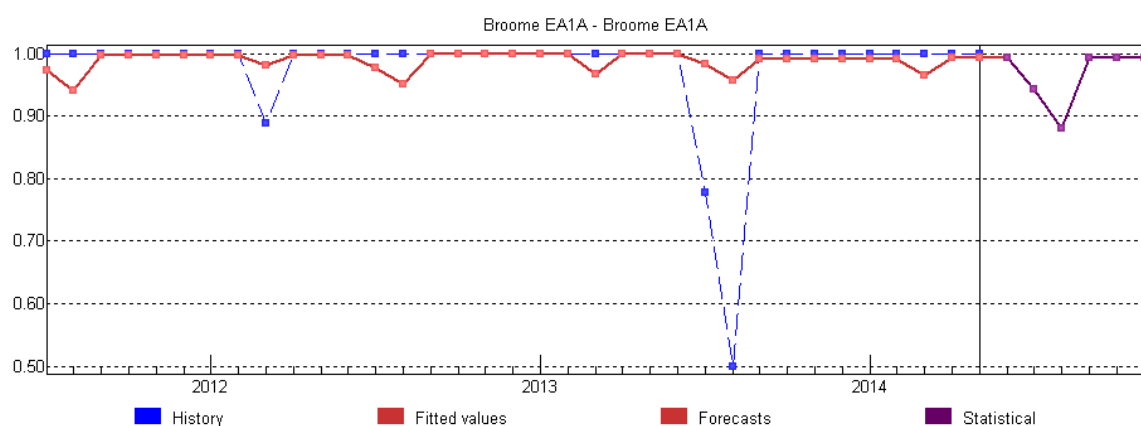
Albany Hospital

Figure 2-9: Albany Hospital, July 2011 - November 2014: EA1A



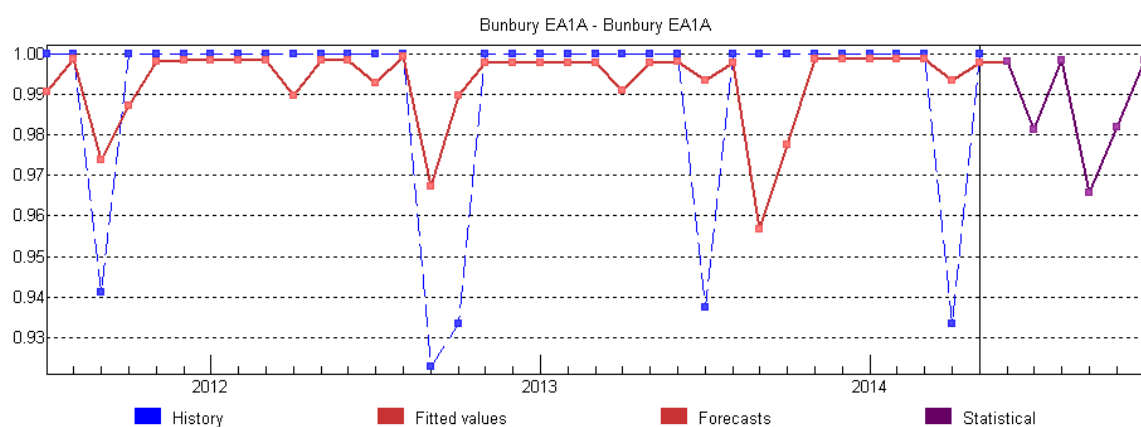
Broome Hospital

Figure 2-10: Broome Hospital, July 2011 - November 2014: EA1A



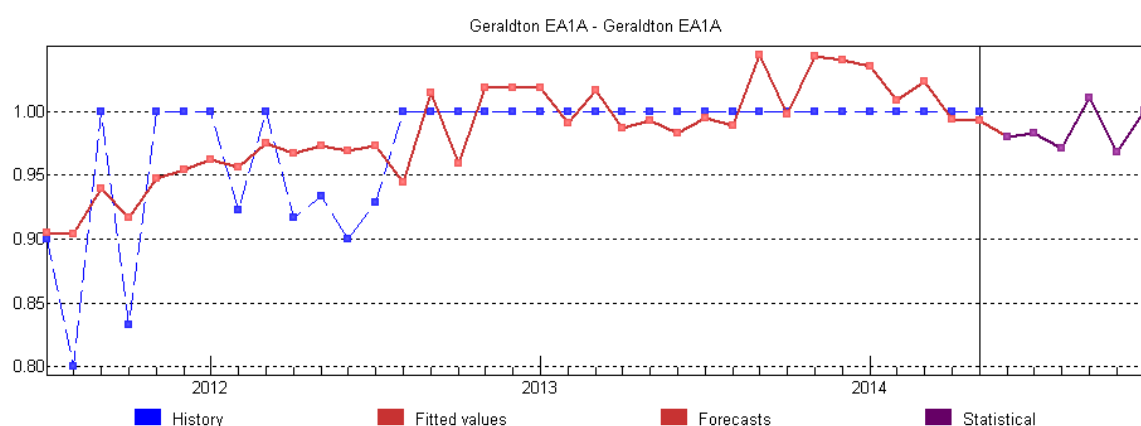
Bunbury Hospital

Figure 2-11: Bunbury Hospital, July 2011 - November 2014: EA1A



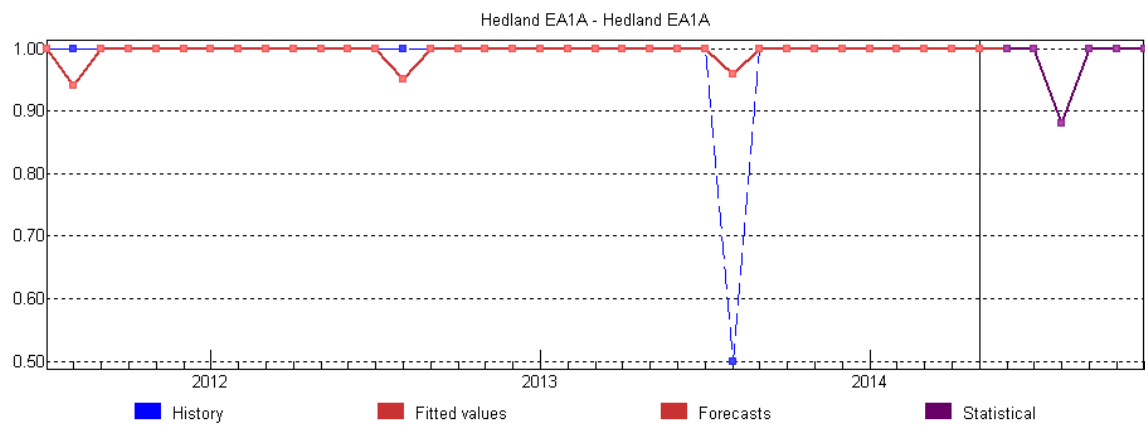
Geraldton Hospital

Figure 2-12: Geraldton Hospital, July 2011 - November 2014: EA1A



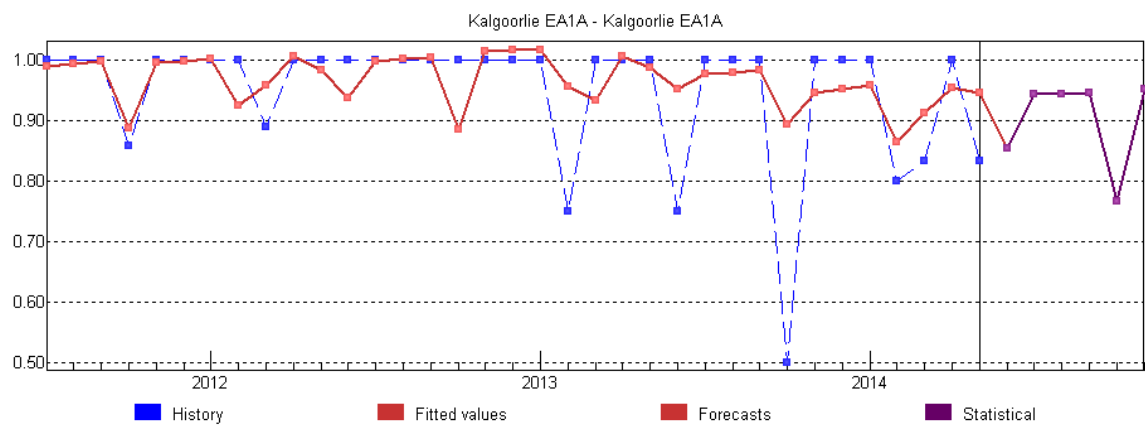
Hedland Hospital

Figure 2-13: Hedland Hospital, July 2011 - November 2014: EA1A



Kalgoorlie Hospital

Figure 2-14: Kalgoorlie Hospital, July 2011 - November 2014: EA1A

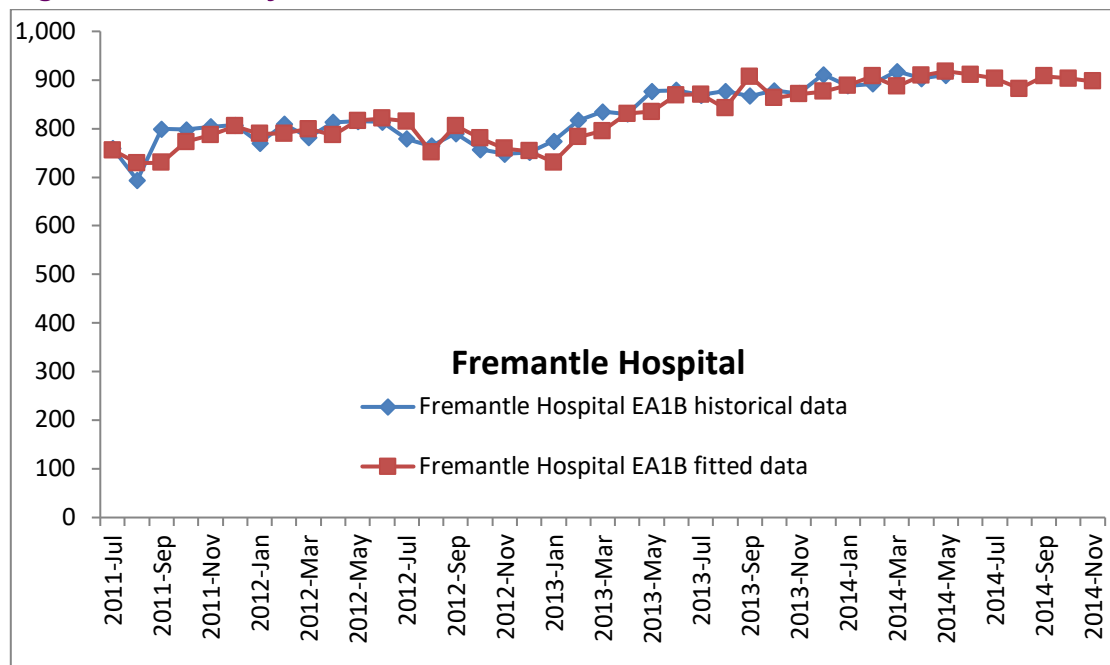


Appendix 3: PMR measure EA1 – Triage sub category 2

Indicator EA1: Hospital - triage sub-category 2 (seen within 10 minutes)

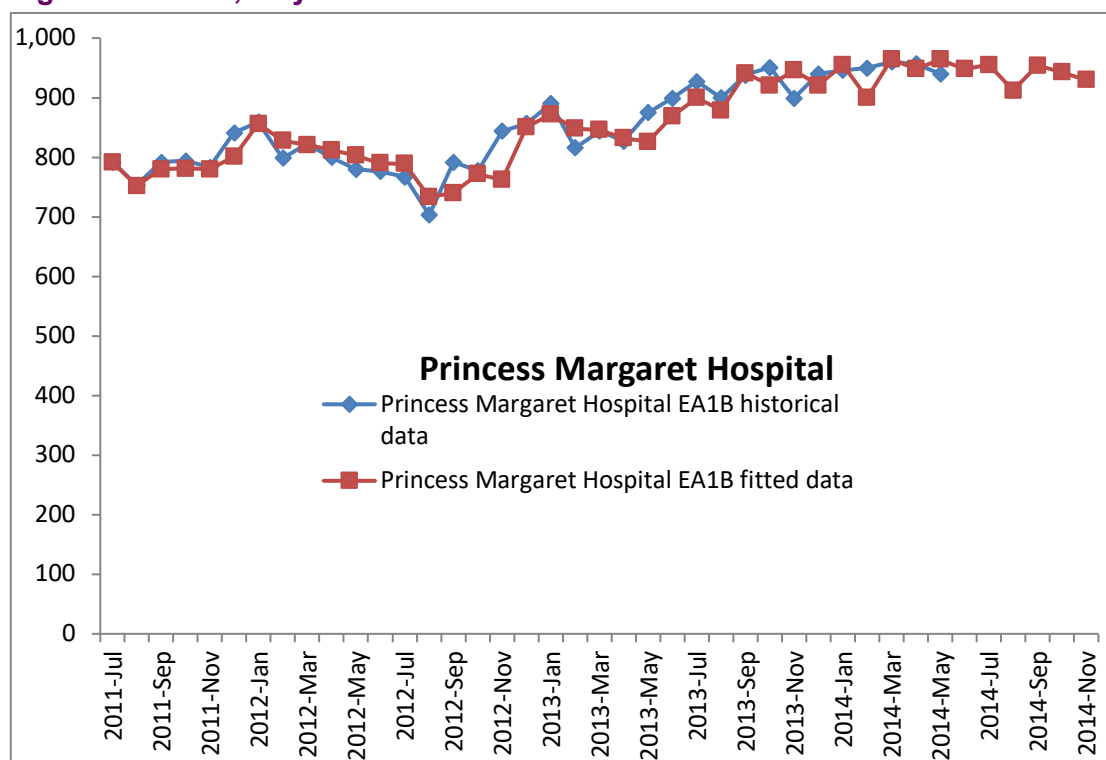
Fremantle Hospital

Figure 3-1: FH, July 2011 - November 2014: EA1B



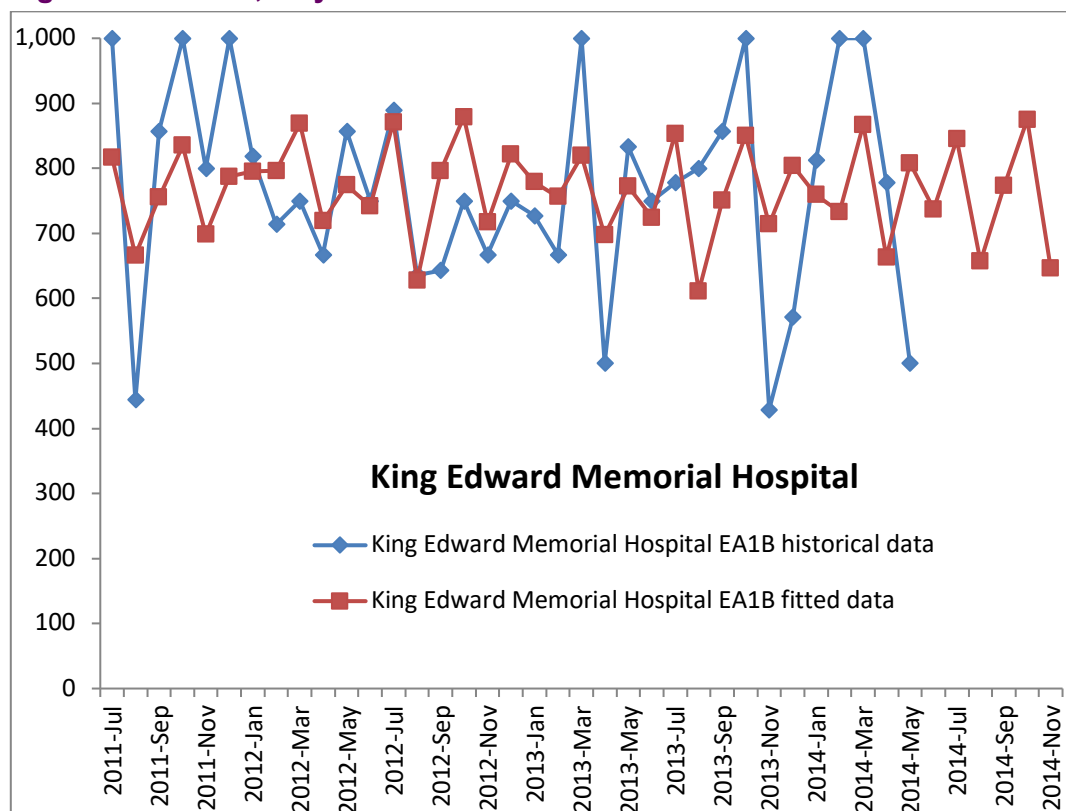
Princess Margaret Hospital

Figure 3-2: PMH, July 2011 - November 2014: EA1B



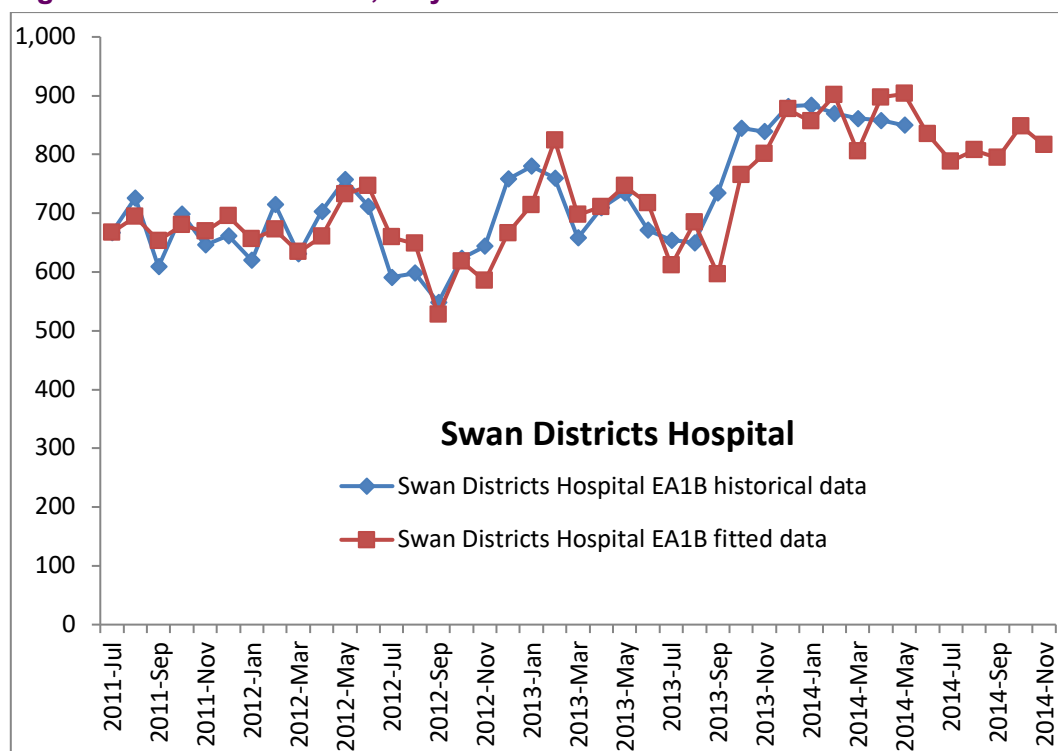
King Edward Memorial Hospital

Figure 3-3: KEMH, July 2011 - November 2014: EA1B



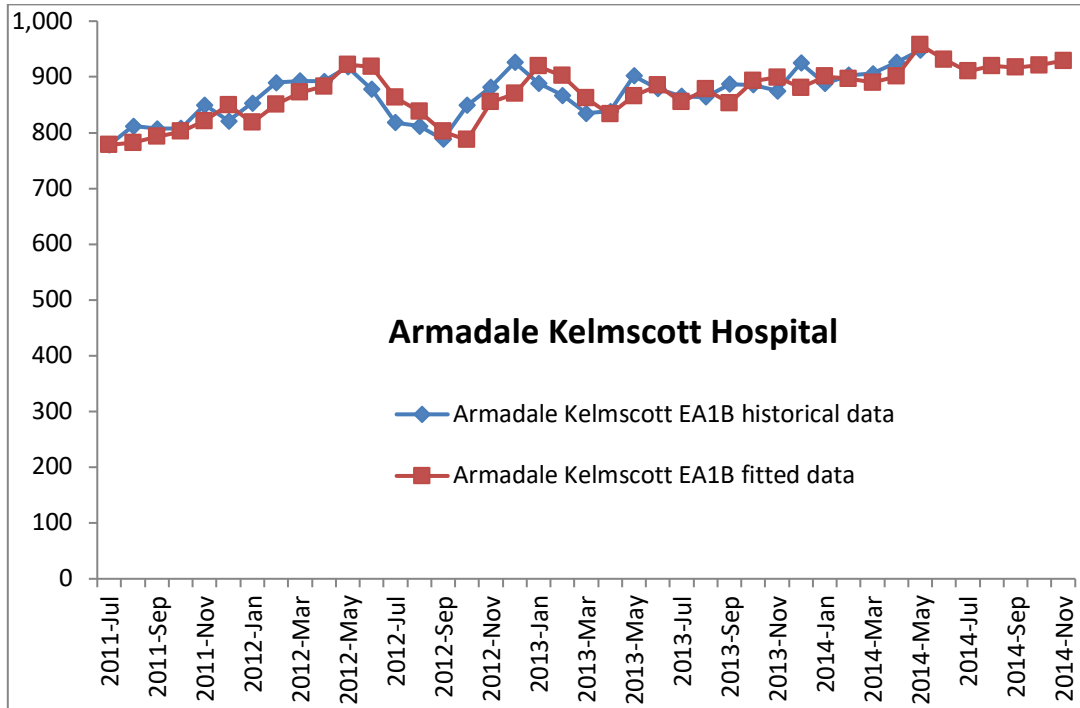
Swan Districts Hospital

Figure 3-4: Swan Districts, July 2011 - November 2014: EA1B



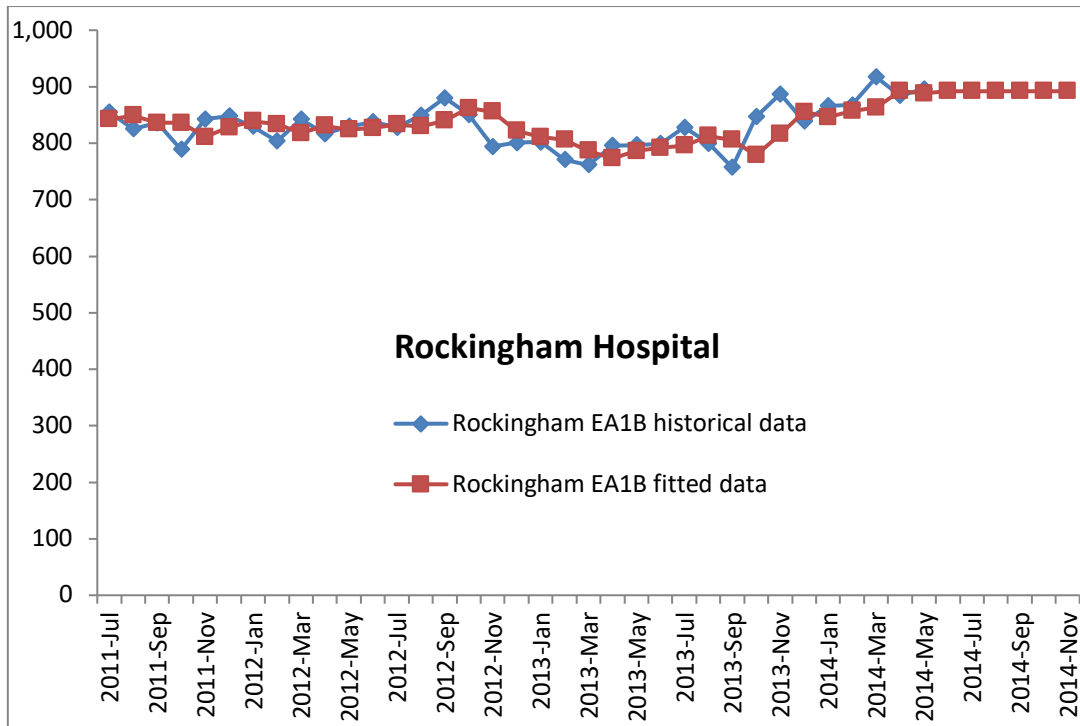
Armada-Kelmscott Hospital

Figure 3-5: Armada-Kelmscott, July 2011 - November 2014: EA1B



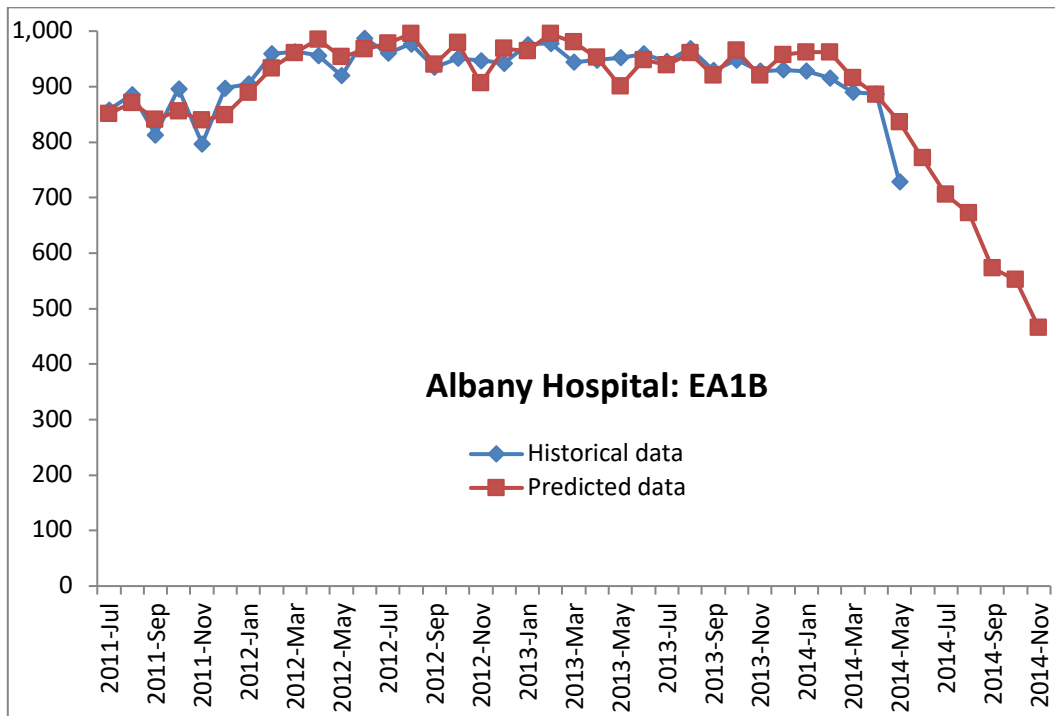
Rockingham Hospital

Figure 3-6: Rockingham Hospital, July 2011 - November 2014: EA1B



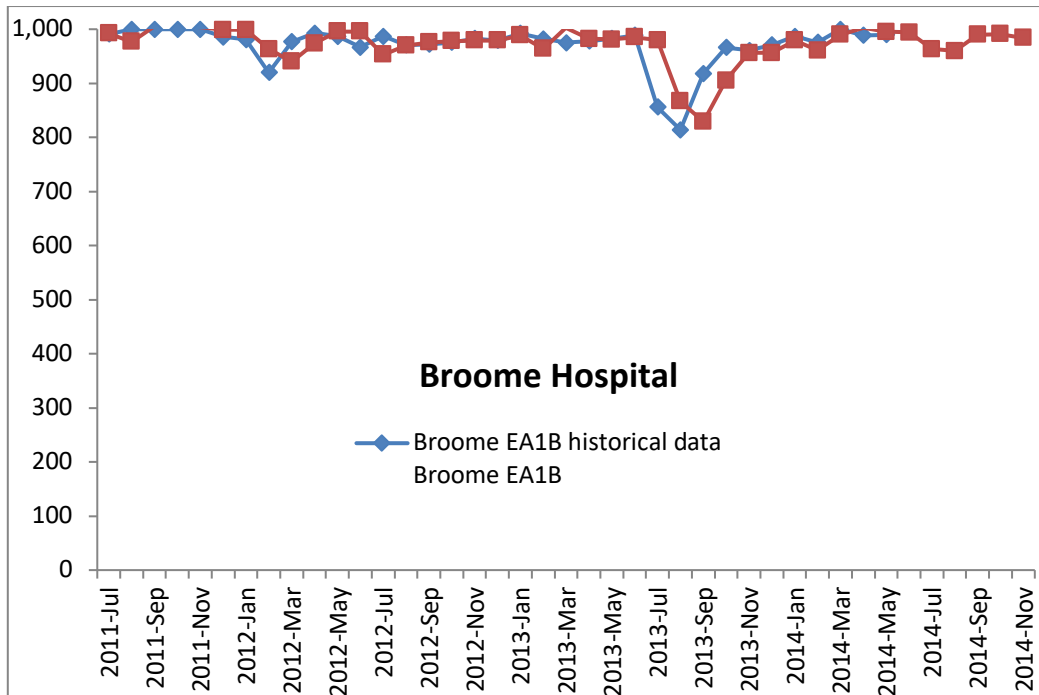
Albany Hospital

Figure 3-7: Albany Hospital, July 2011 - November 2014: EA1B



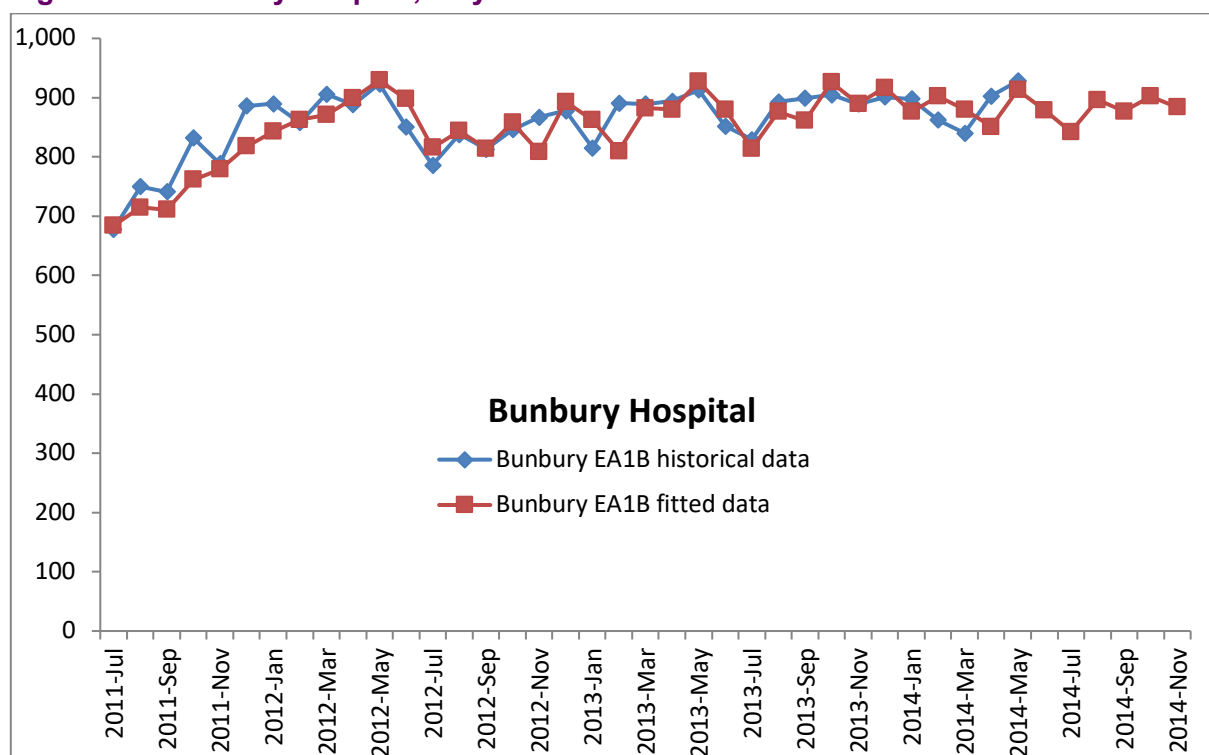
Broome Hospital

Figure 3-8: Broome Hospital, July 2011 - November 2014: EA1B



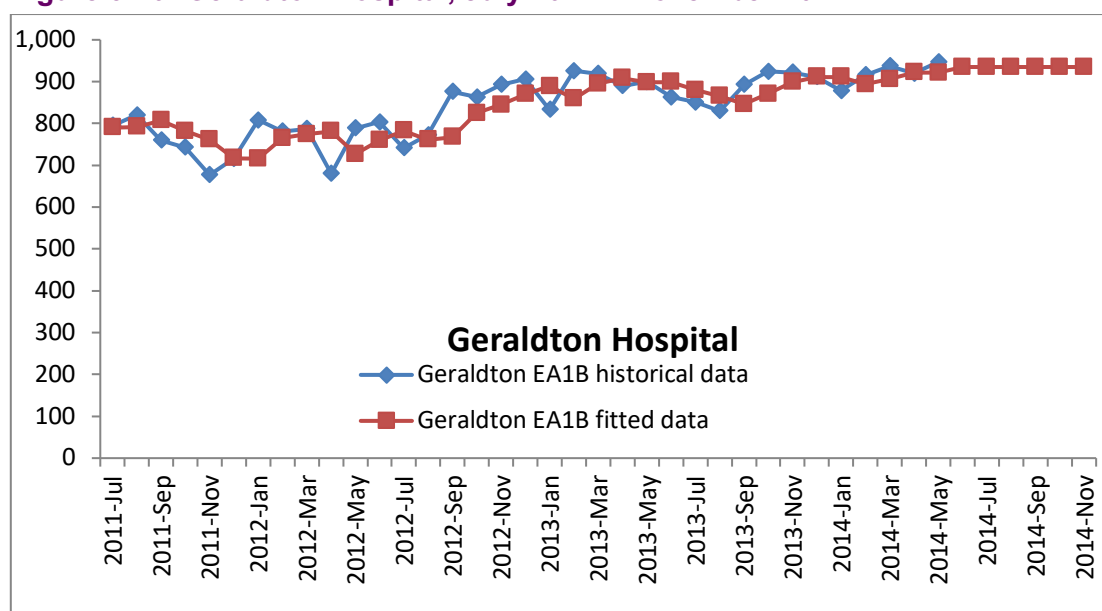
Bunbury Hospital

Figure 3-9: Bunbury Hospital, July 2011 - November 2014: EA1B



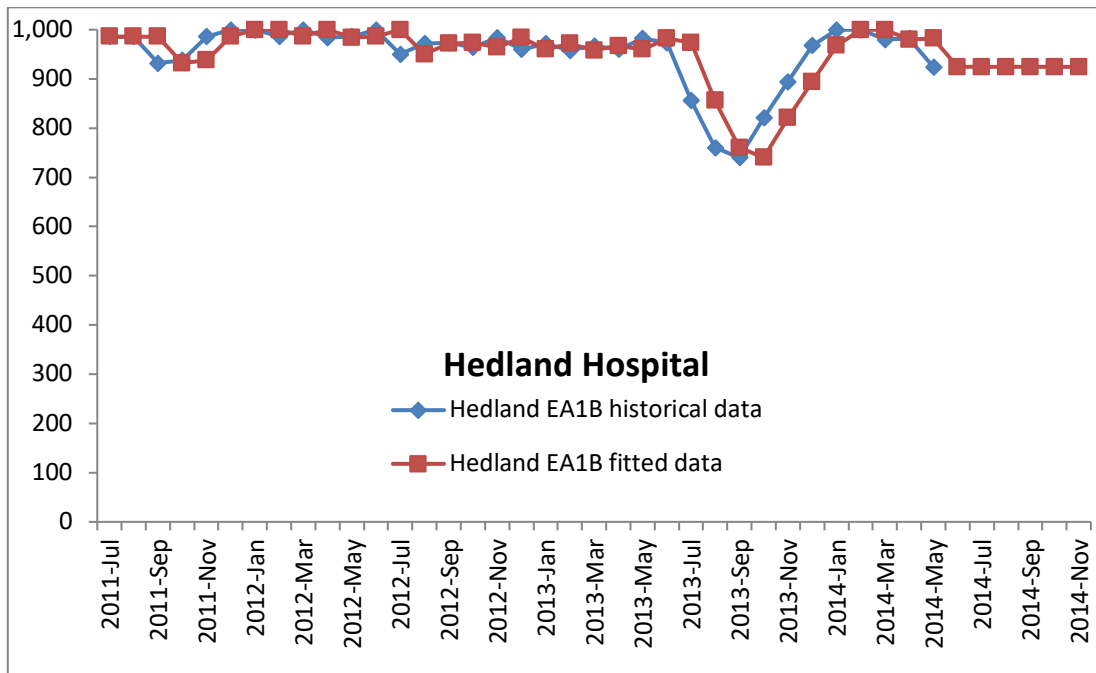
Geraldton Hospital

Figure 3-10: Geraldton Hospital, July 2011 - November 2014: EA1B



Hedland Hospital

Figure 3-11: Hedland Hospital, July 2011 - November 2014: EA1B



Appendix 4: PMR measure EA1 – 6 month projections

Indicator EA1: Hospital - triage sub-category & 6 month projection

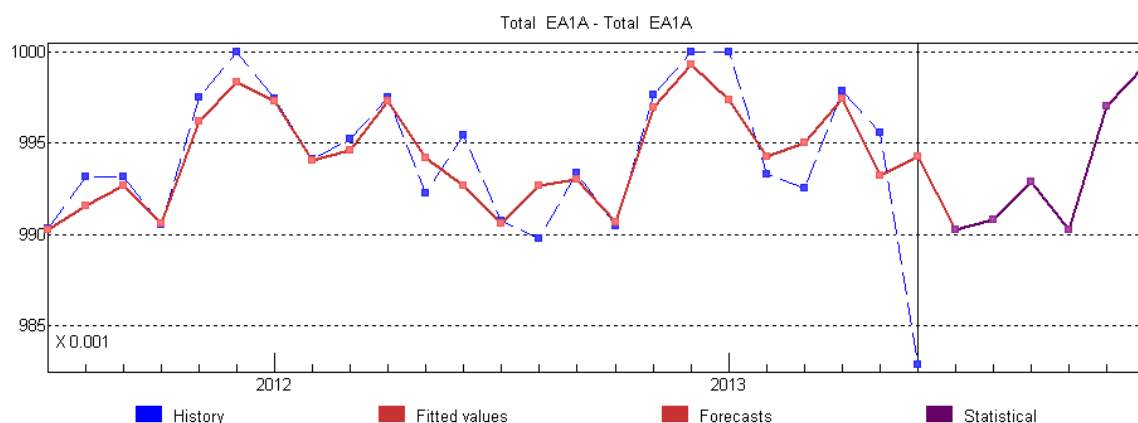
A tryout was undertaken for the period July 2011 to June 2013, which

- consisted of historic data for the period July 2011 to December 2012 and
- forecasting for the six month period from January to June 2013.

Total hospitals

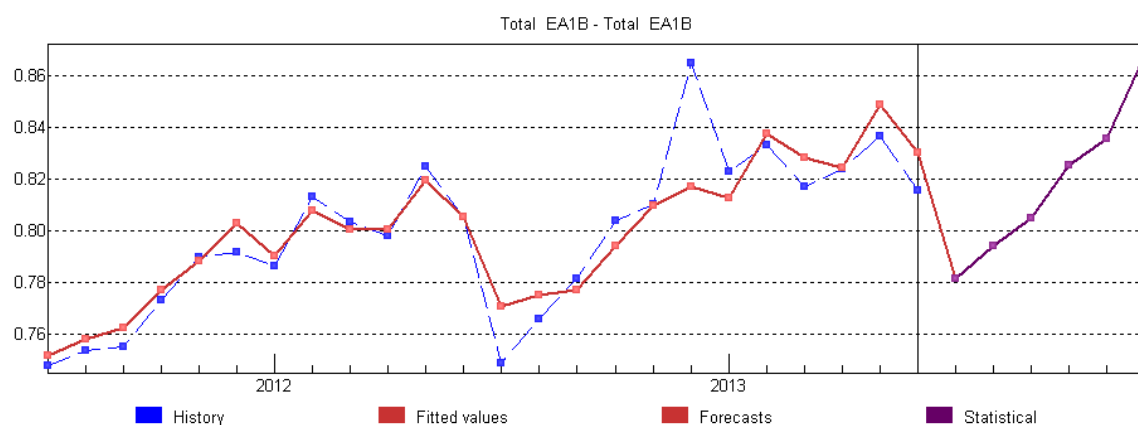
Triage category 1 (EA1A)

Figure 4-1: Total hospitals, July 2011 - June 2013: EA1A (Triage category 1)



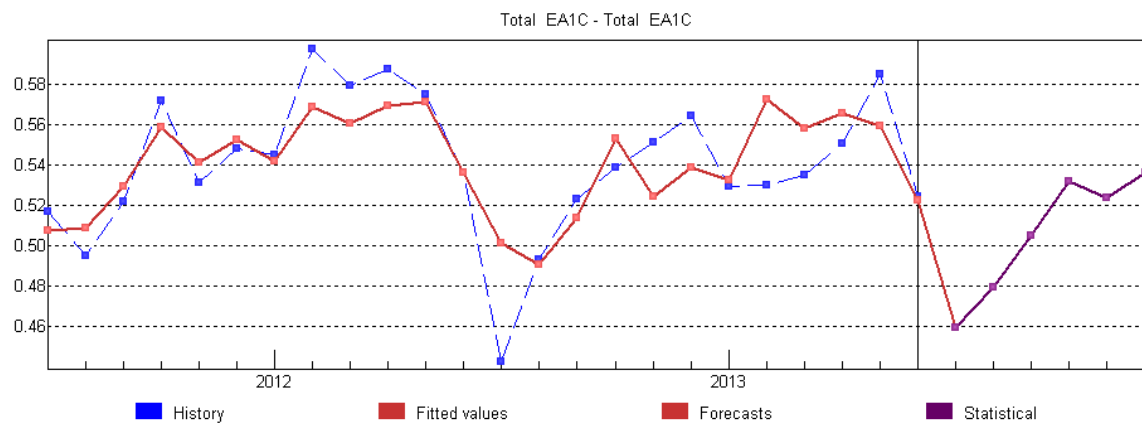
Triage category 2 (EA1B)

Figure 4-2: Total hospitals, July 2011 - June 2013: EA1B (Triage category 2)



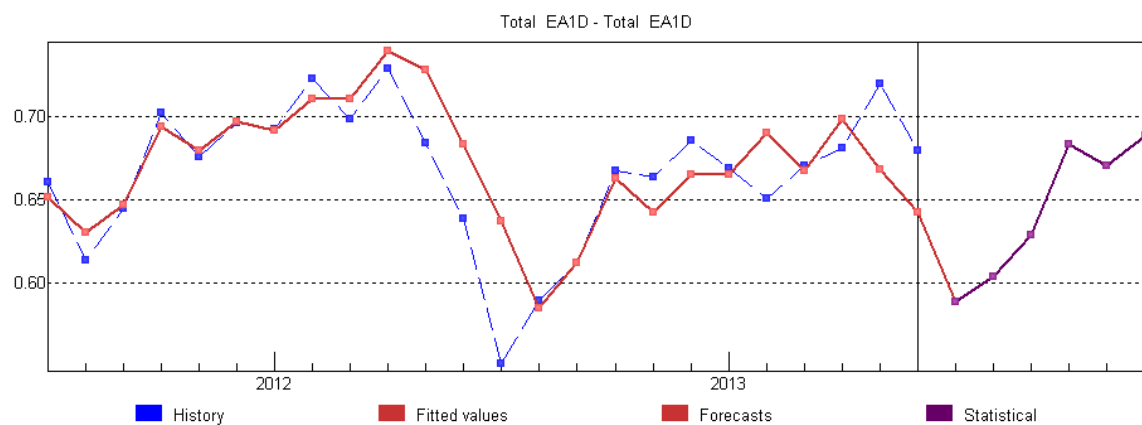
Triage category 3 (EA1C)

Figure 4-3: Total hospitals, July 2011 - June 2013: EA1C (Triage category 3)



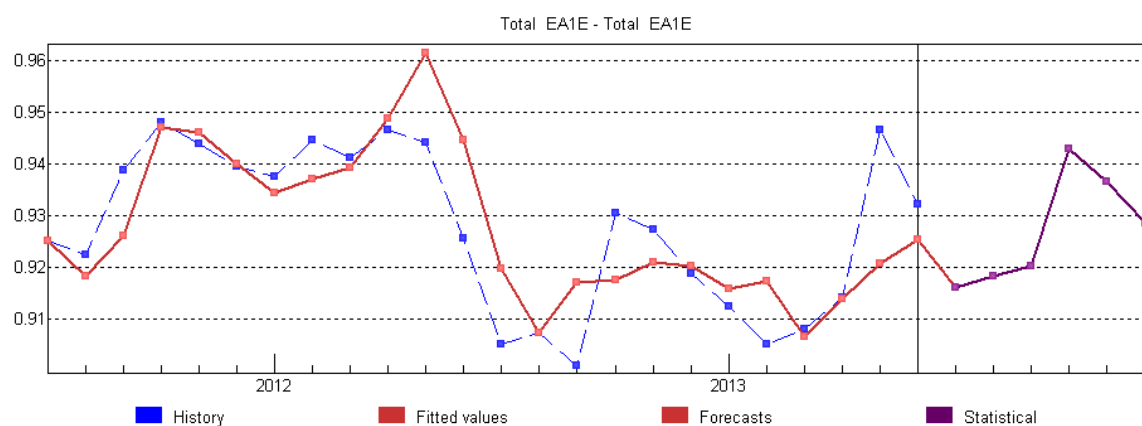
Triage category 4 (EA1D)

Figure 4-4: Total hospitals, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

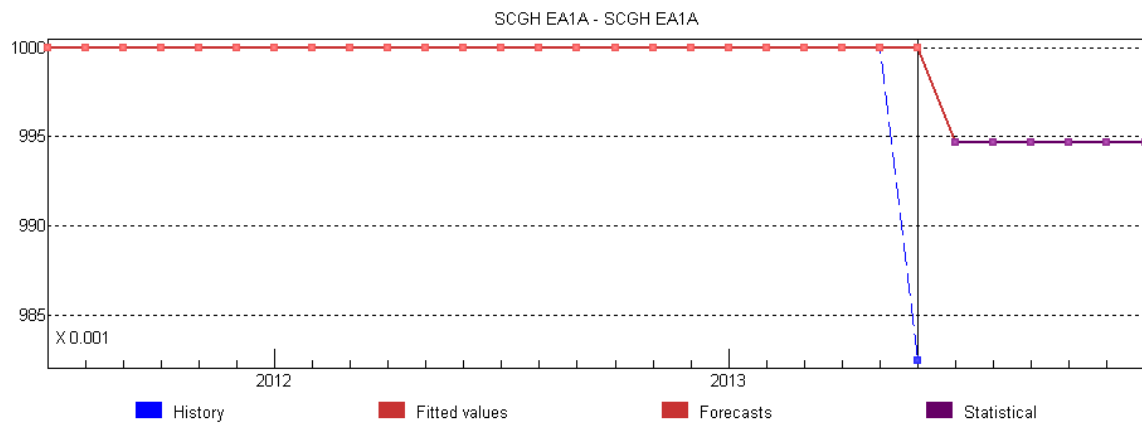
Figure 4-5: Total hospitals, July 2011 - June 2013: EA1E (Triage category 5)



Sir Charles Gairdner Hospital:

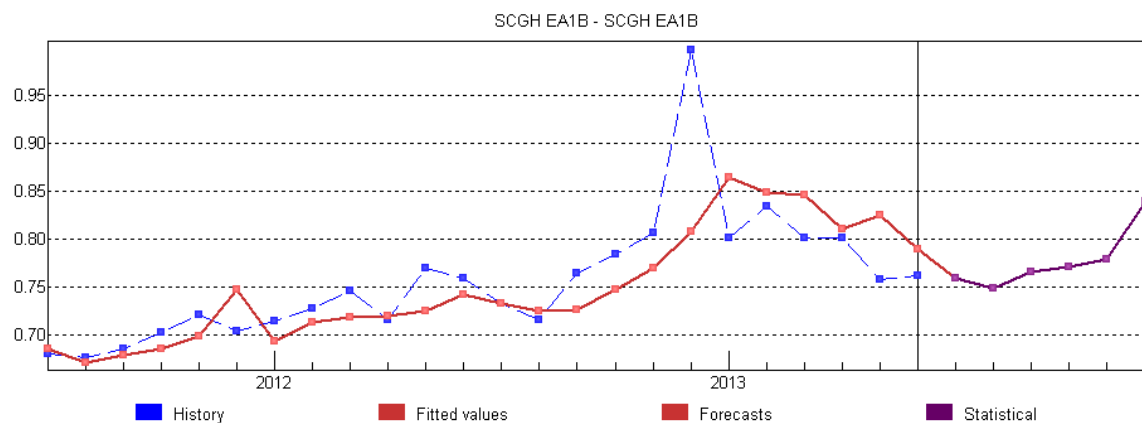
Triage category 1 (EA1A)

Figure 4-6: SCGH, July 2011 - June 2013: EA1A (Triage category 1)



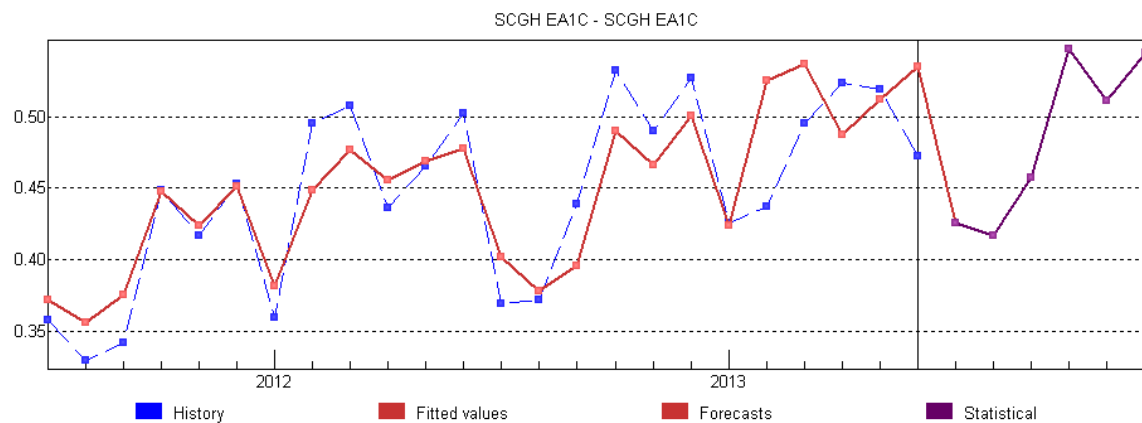
Triage category 2 (EA1B)

Figure 4-7: SCGH, July 2011 - June 2013: EA1B (Triage category 2)



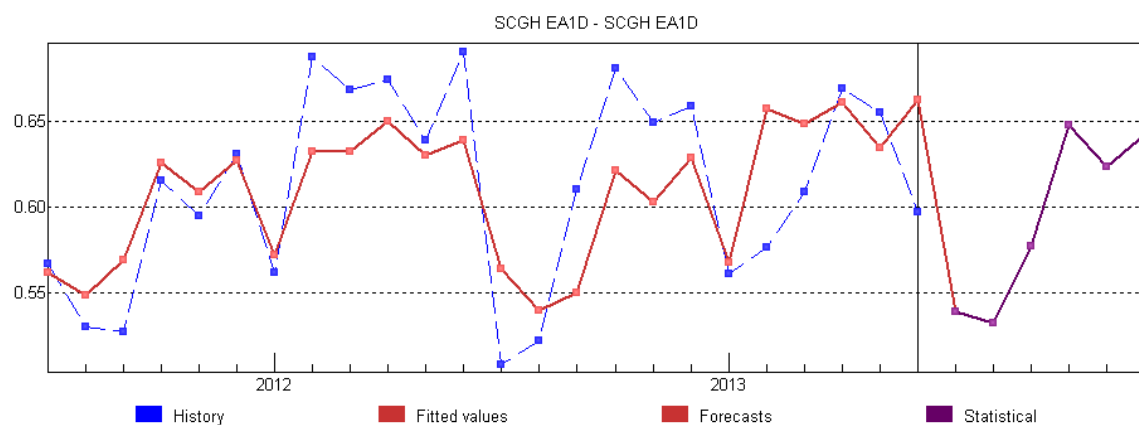
Triage category 3 (EA1C)

Figure 4-8: SCGH, July 2011 - June 2013: EA1C (Triage category 3)



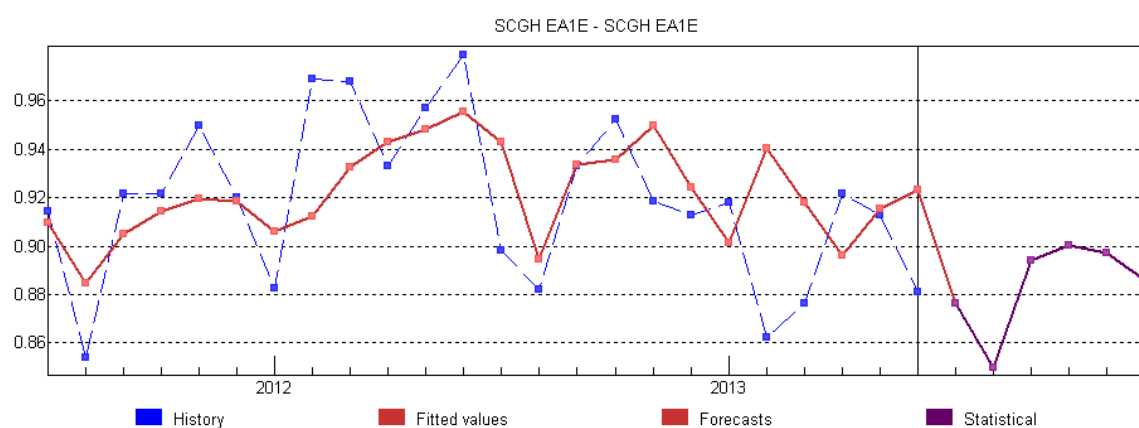
Triage category 4 (EA1D)

Figure 4-9: SCGH, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

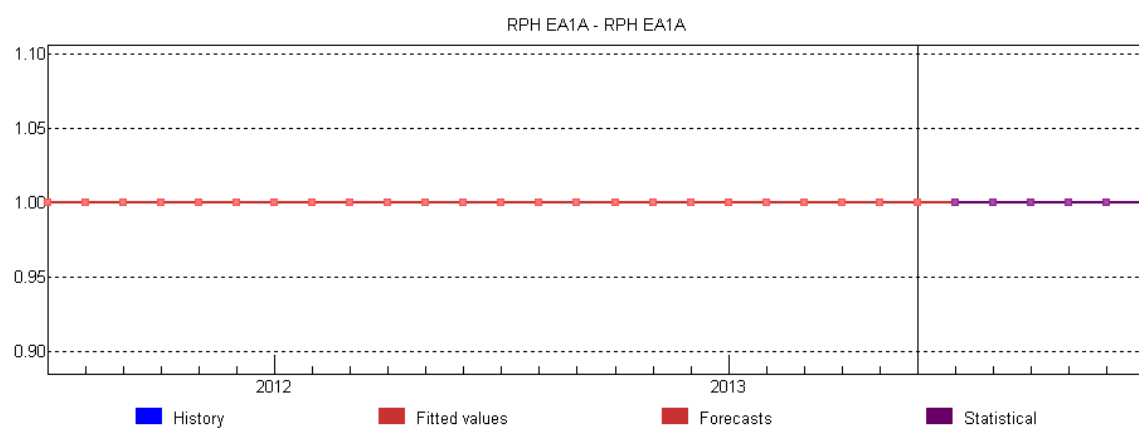
Figure 4-10: SCGH, July 2011 - June 2013: EA1E (Triage category 5)



Royal Perth Hospital

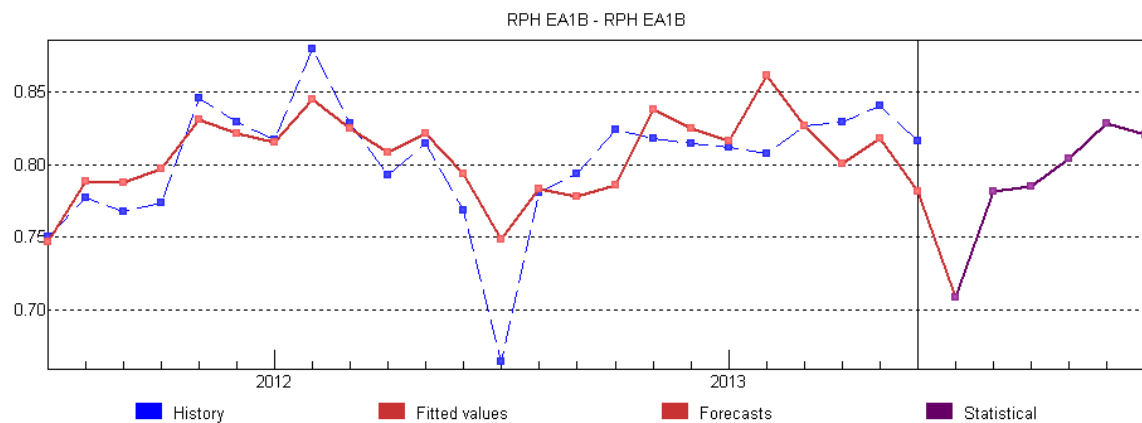
Triage category 1 (EA1A)

Figure 4-11: RPH, July 2011 - June 2013: EA1A (Triage category 1)



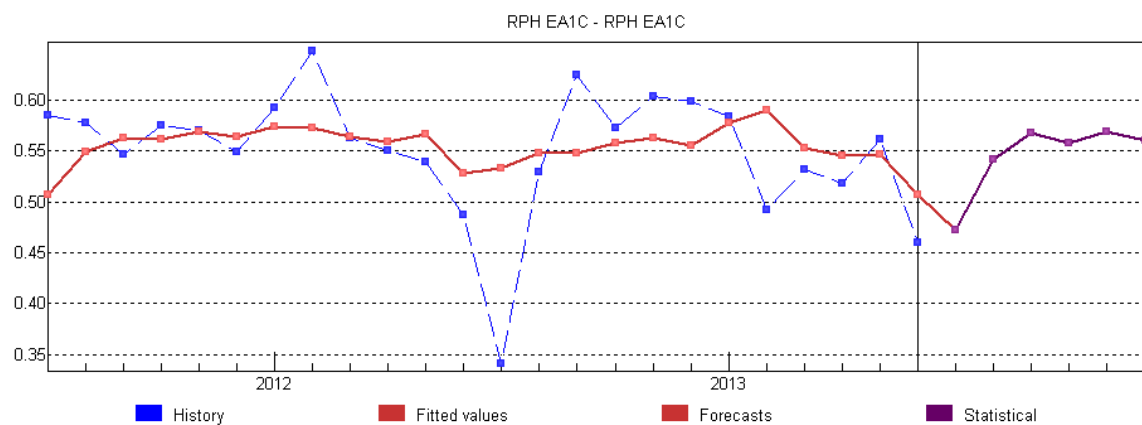
Triage category 2 (EA1B)

Figure 4-12: RPH, July 2011 - June 2013: EA1B (Triage category 2)



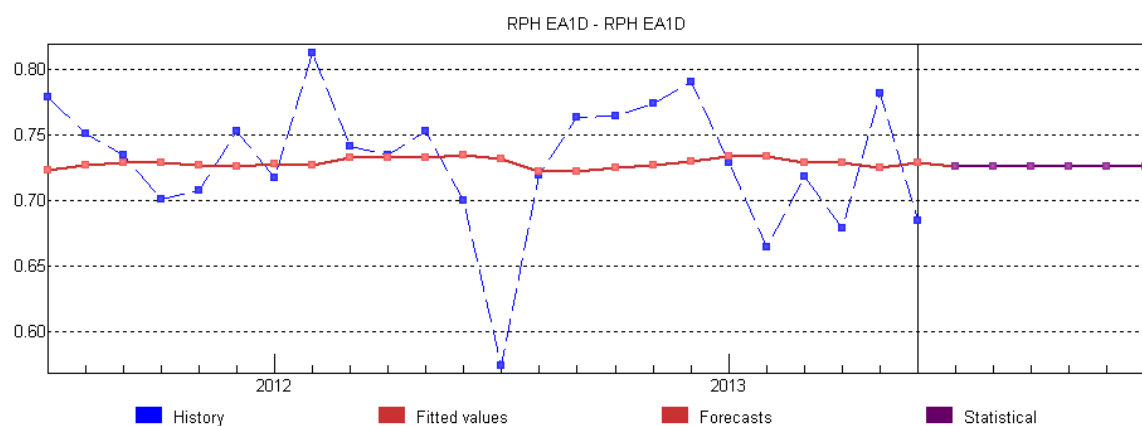
Triage category 3 (EA1C)

Figure 4-13: RPH, July 2011 - June 2013: EA1C (Triage category 3)



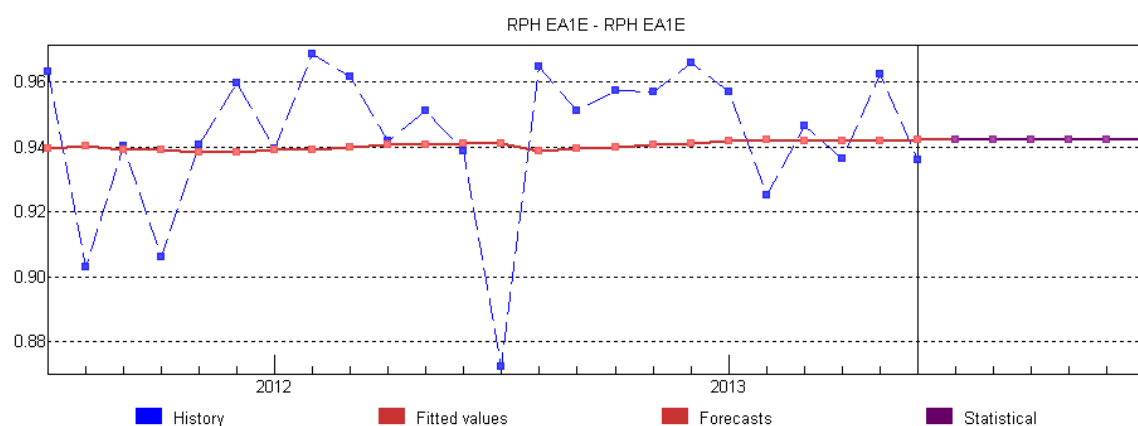
Triage category 4 (EA1D)

Figure 4-14: RPH, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

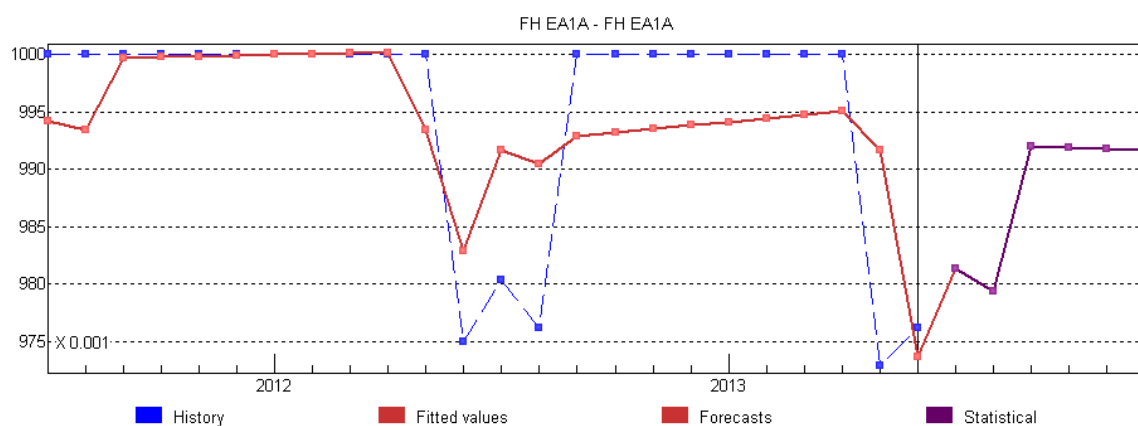
Figure 4-15: RPH, July 2011 - June 2013: EA1E (Triage category 5)



Fremantle Hospital

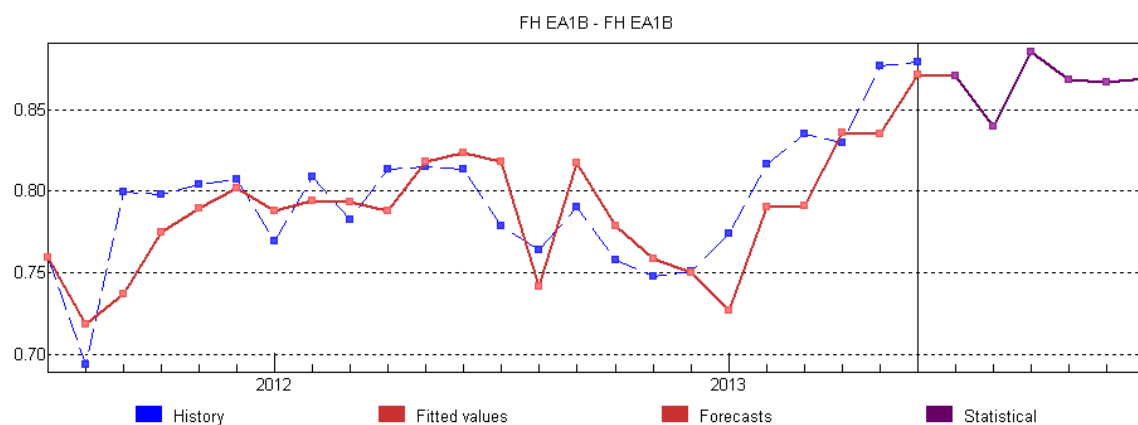
Triage category 1 (EA1A)

Figure 4-16: FH, July 2011 - June 2013: EA1A (Triage category 1)



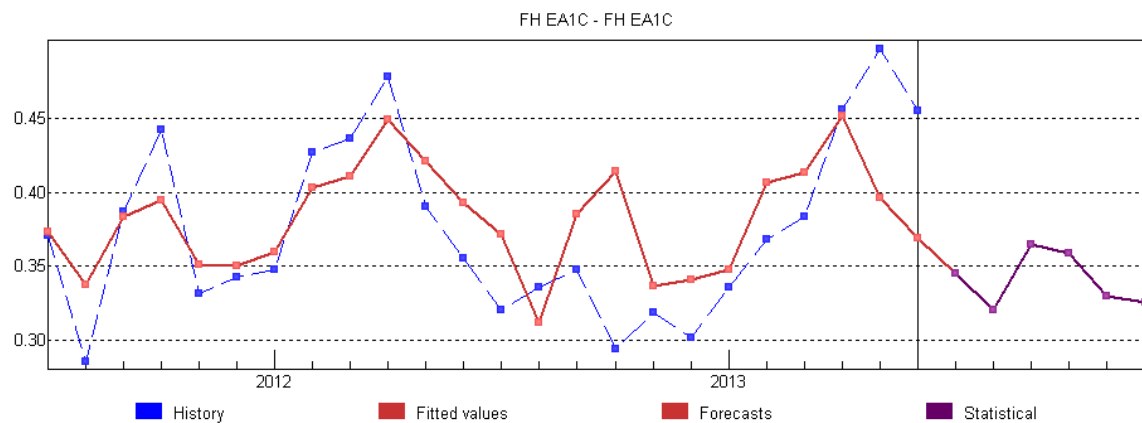
Triage category 2 (EA1B)

Figure 4-17: FH, July 2011 - June 2013: EA1B (Triage category 2)



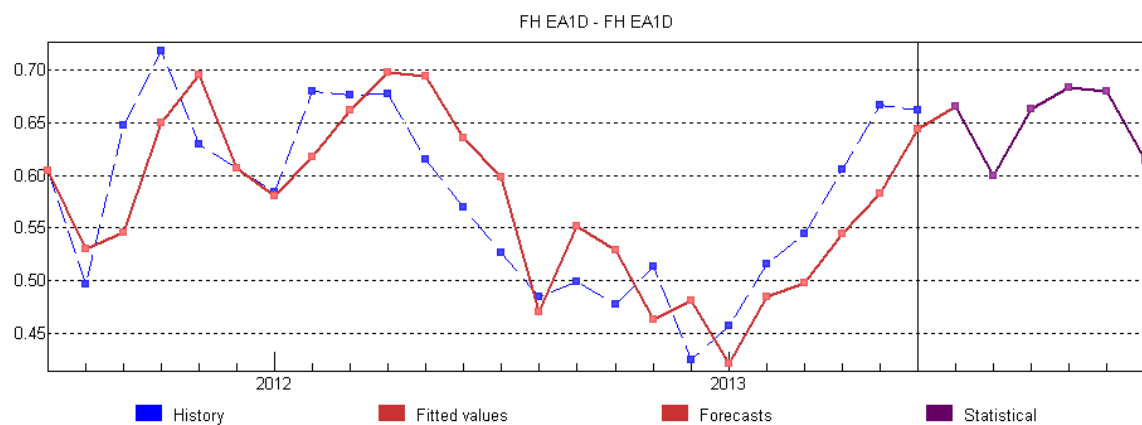
Triage category 3 (EA1C)

Figure 4-18: FH, July 2011 - June 2013: EA1C (Triage category 3)



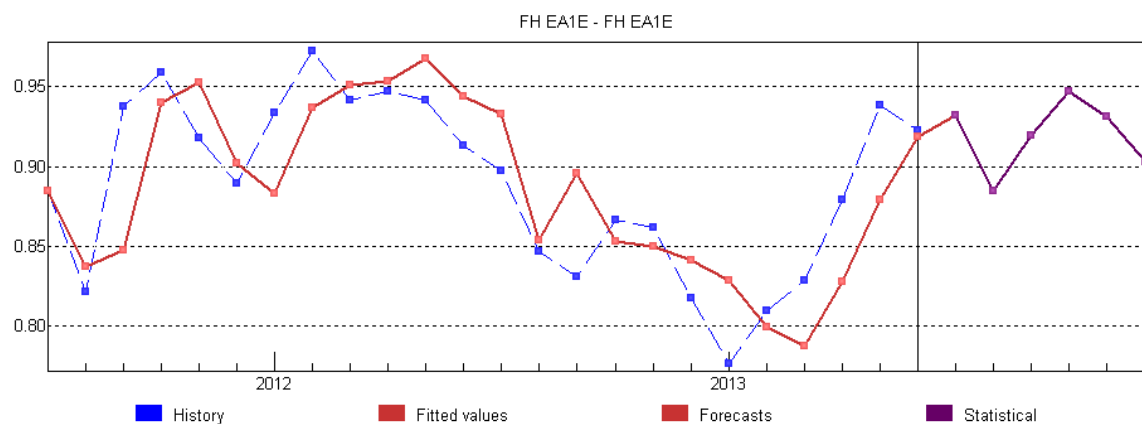
Triage category 4 (EA1D)

Figure 4-19: FH, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

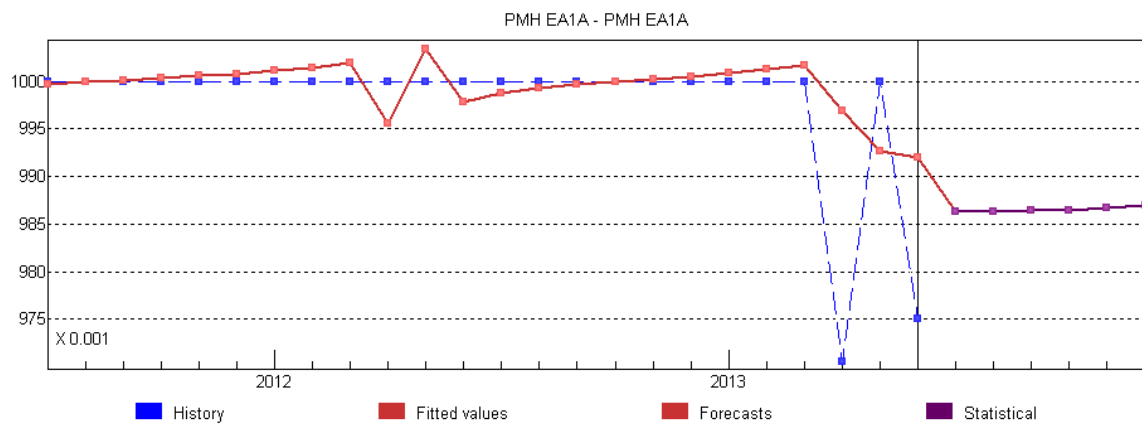
Figure 4-20: FH, July 2011 - June 2013: EA1E (Triage category 5)



Princess Margaret Hospital

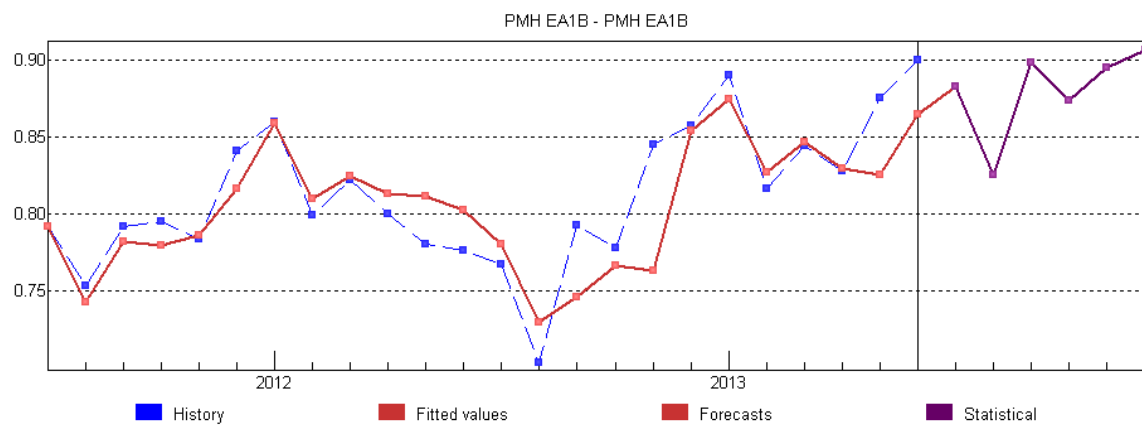
Triage category 1 (EA1A)

Figure 4-21: PMH, July 2011 - June 2013: EA1A (Triage category 1)



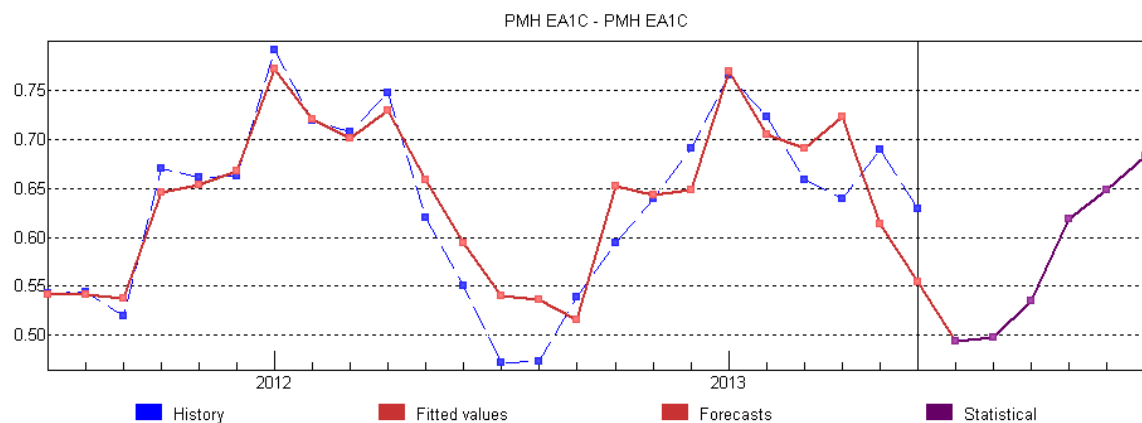
Triage category 2 (EA1B)

Figure 4-22: PMH, July 2011 - June 2013: EA1B (Triage category 2)



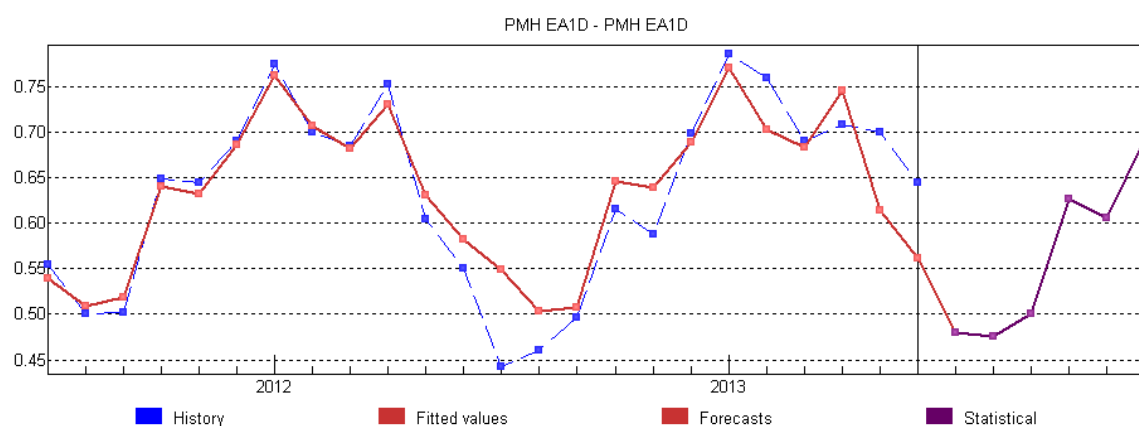
Triage category 3 (EA1C)

Figure 4-23: PMH, July 2011 - June 2013: EA1C (Triage category 3)



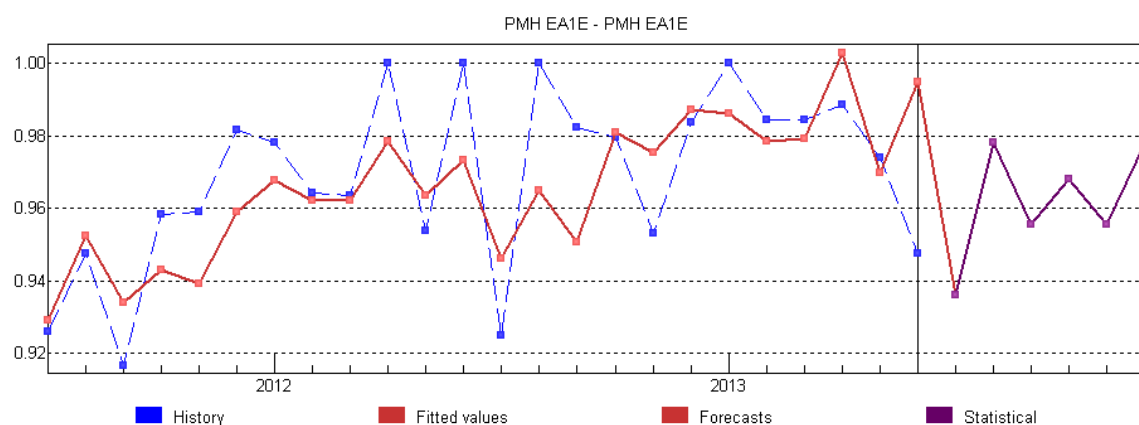
Triage category 4 (EA1D)

Figure 4-24: PMH, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

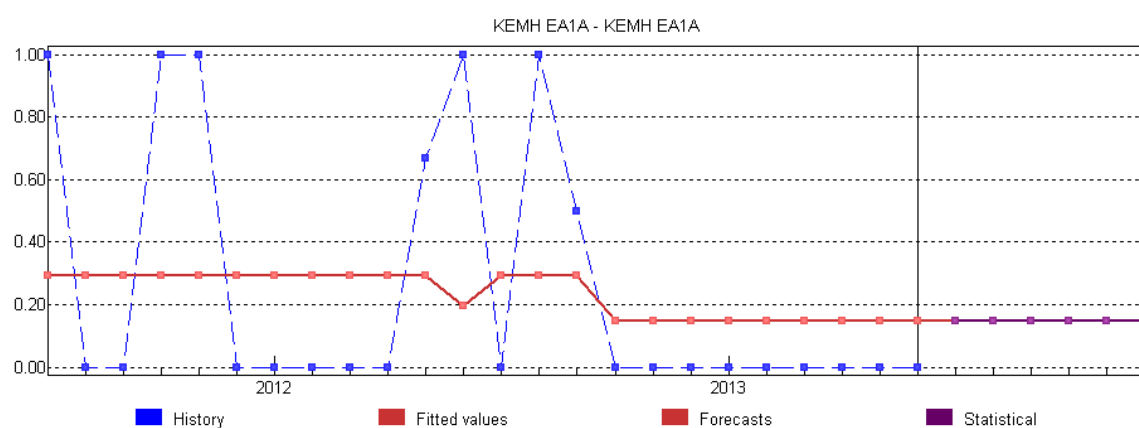
Figure 4-25: PMH, July 2011 - June 2013: EA1E (Triage category 5)



King Edward Memorial Hospital

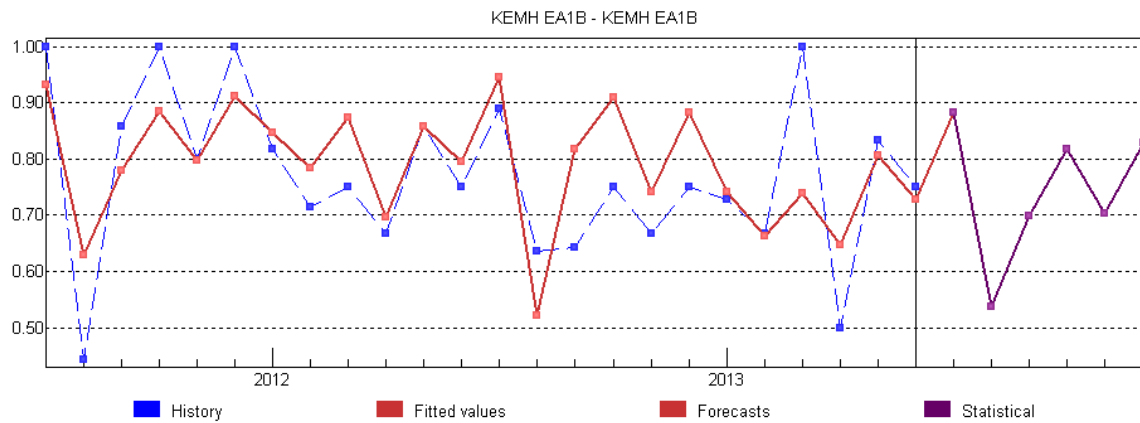
Triage category 1 (EA1A)

Figure 4-26: KEMH, July 2011 - June 2013: EA1A (Triage category 1)



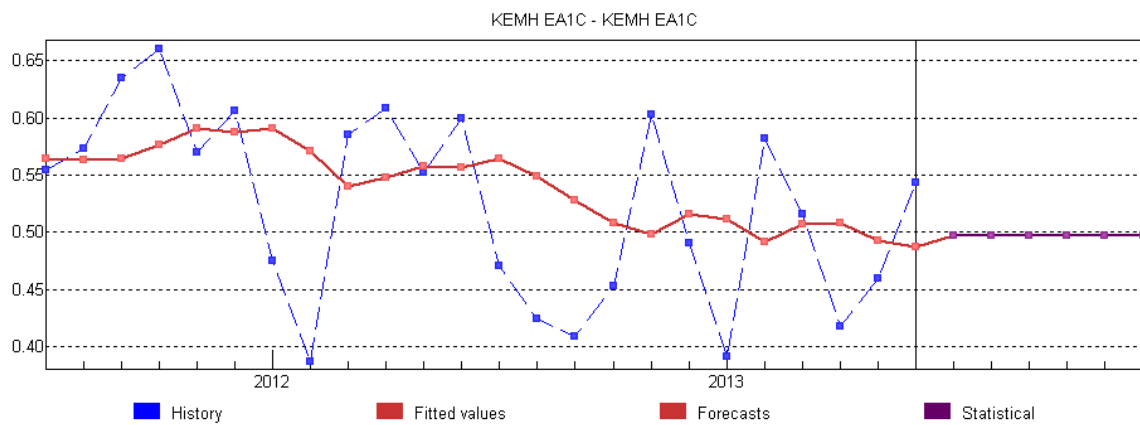
Triage category 2 (EA1B)

Figure 4-27: KEMH, July 2011 - June 2013: EA1B (Triage category 2)



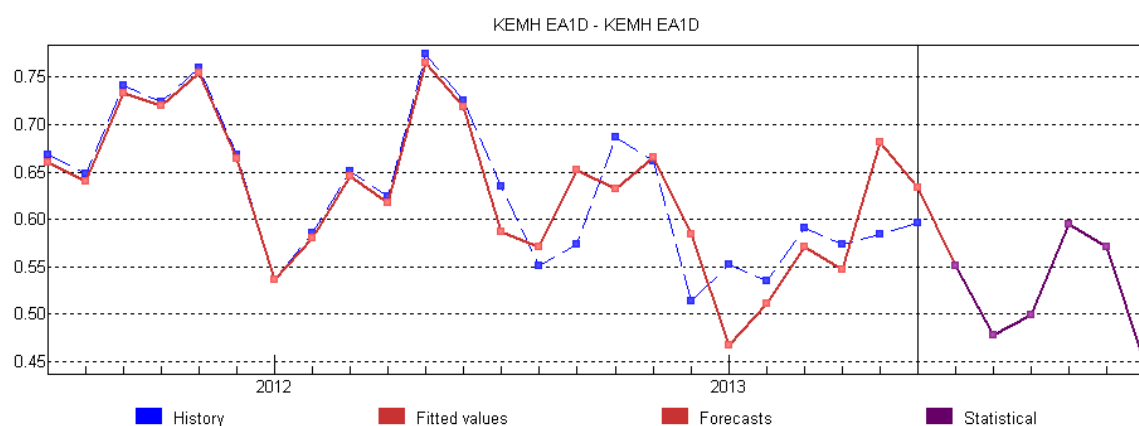
Triage category 3 (EA1C)

Figure 4-28: KEMH, July 2011 - June 2013: EA1C (Triage category 3)



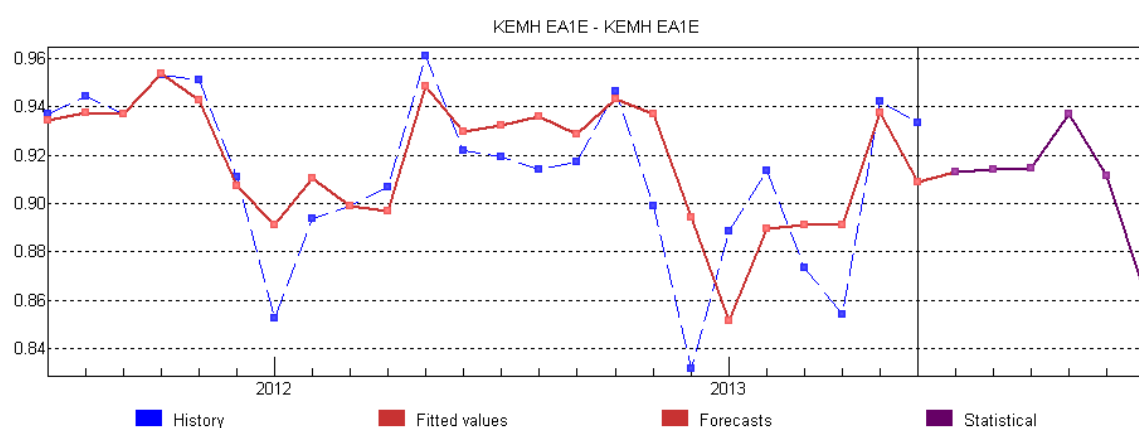
Triage category 4 (EA1D)

Figure 4-29: KEMH, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

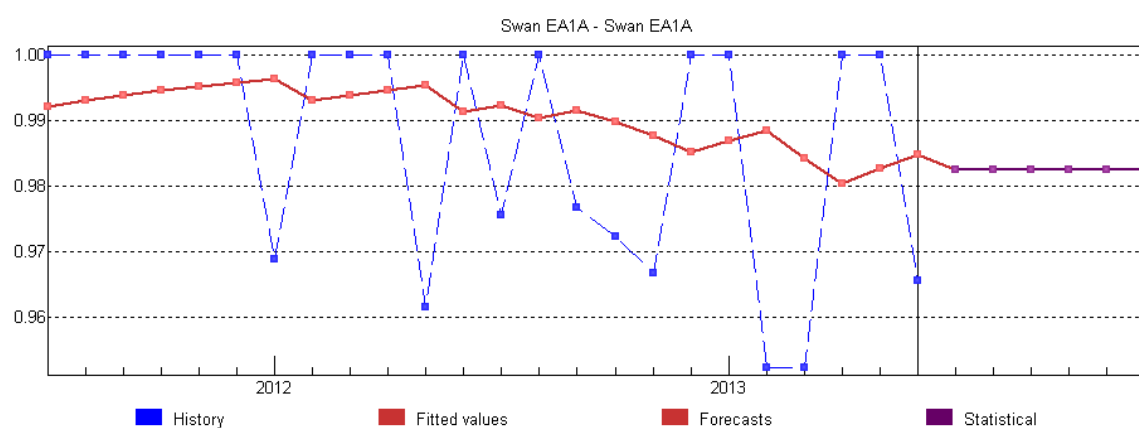
Figure 4-30: KEMH, July 2011 - June 2013: EA1E (Triage category 5)



Swan Districts Hospital

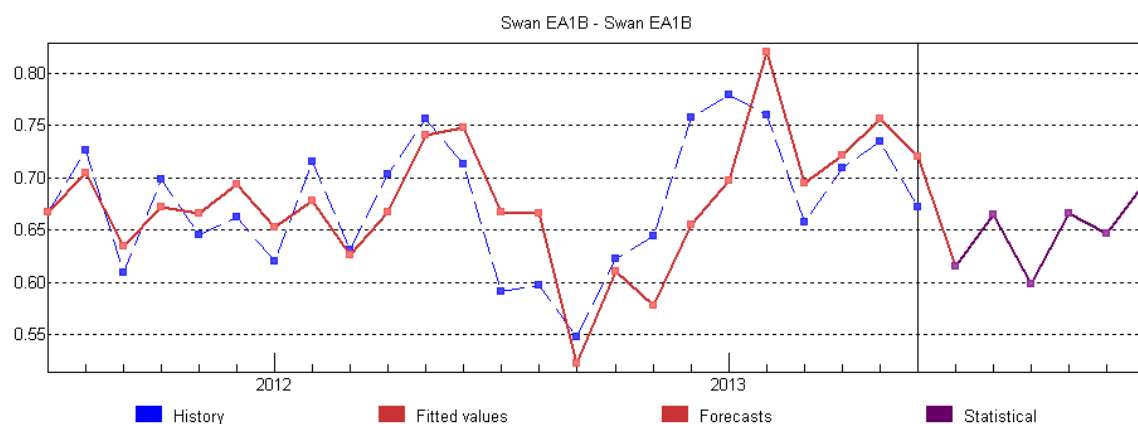
Triage category 1 (EA1A)

Figure 4-31: Swan Districts Hospital, July 2011 - June 2013: EA1A (Triage category 1)



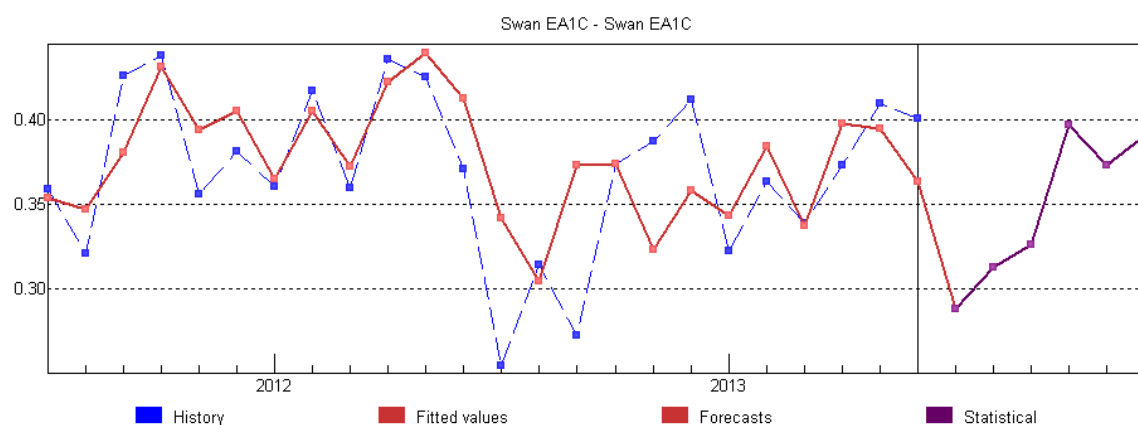
Triage category 2 (EA1B)

Figure 4-32: Swan Districts Hospital, July 2011 - June 2013: EA1B (Triage category 2)



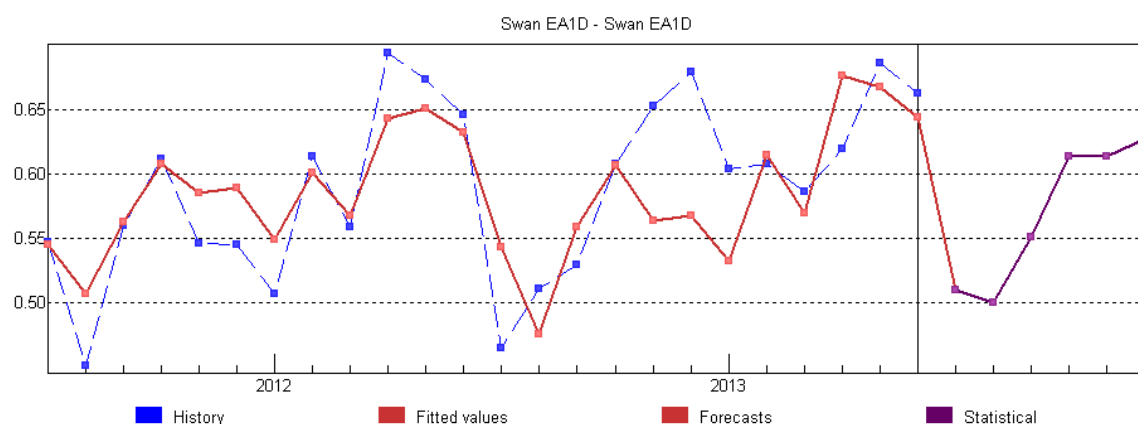
Triage category 3 (EA1C)

Figure 4-33: Swan Districts Hospital, July 2011 - June 2013: EA1C (Triage category 3)



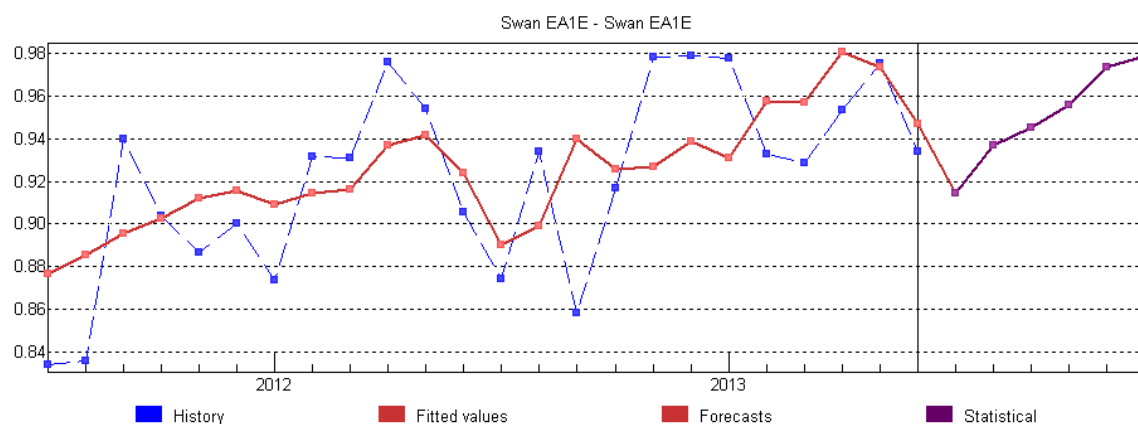
Triage category 4 (EA1D)

Figure 4-34: Swan Districts Hospital, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

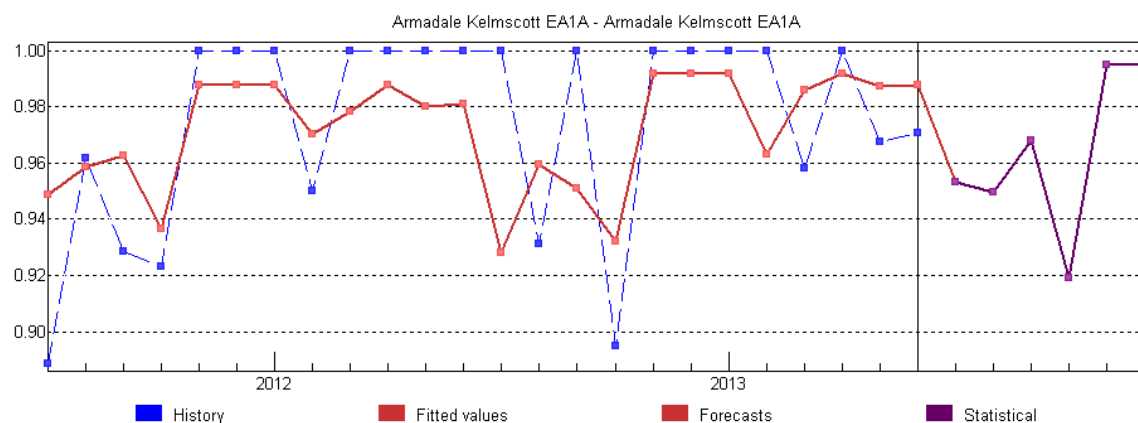
Figure 4-35: Swan Districts Hospital, July 2011 - June 2013: EA1E (Triage category 5)



Armadale Kelmscott Hospital

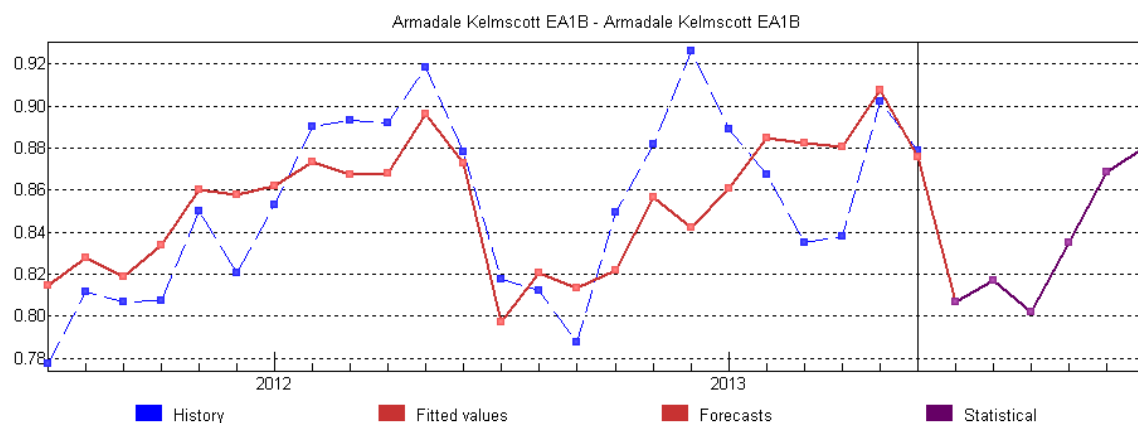
Triage category 1 (EA1A)

Figure 4-36: Armadale Kelmscott Hospital, July 2011 - June 2013: EA1A (Triage category 1)



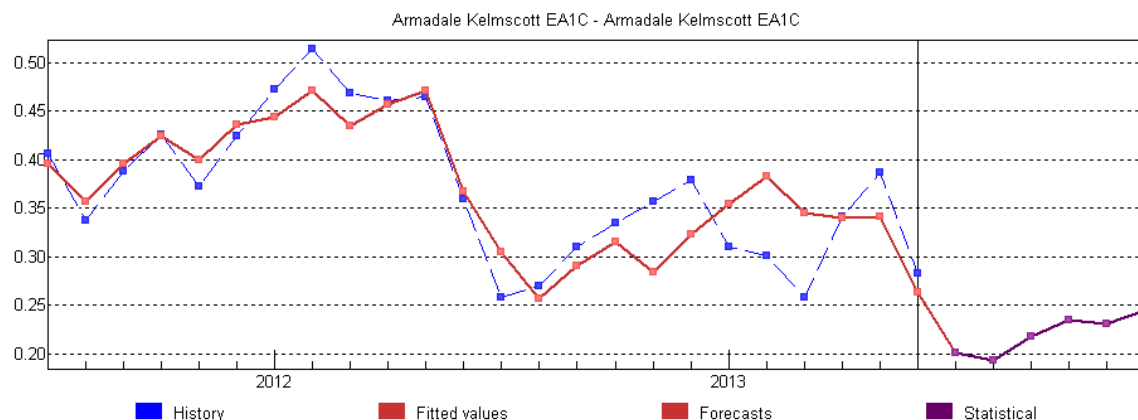
Triage category 2 (EA1B)

Figure 4-37: Armadale Kelmscott Hospital, July 2011 - June 2013: EA1B (Triage category 2)



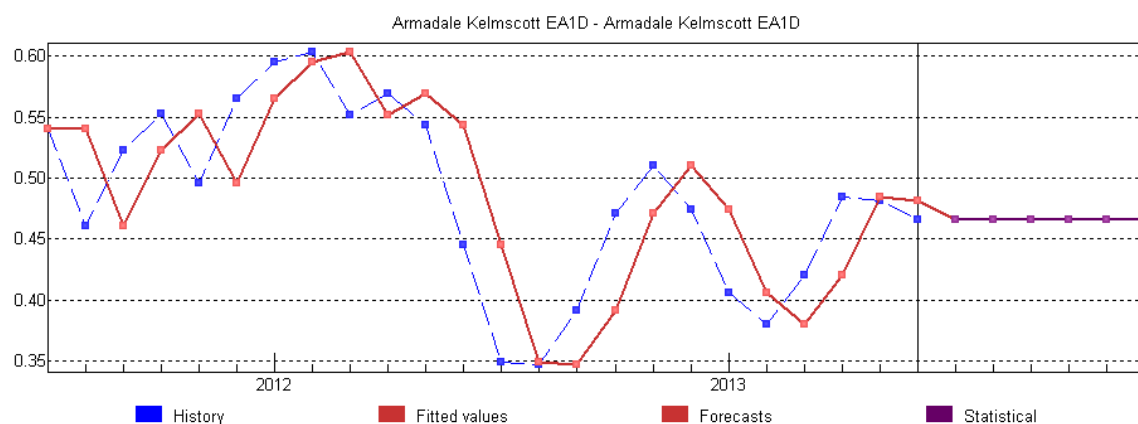
Triage category 3 (EA1C)

Figure 4-38: Armadale Kelmscott Hospital, July 2011 - June 2013: EA1C (Triage category 3)



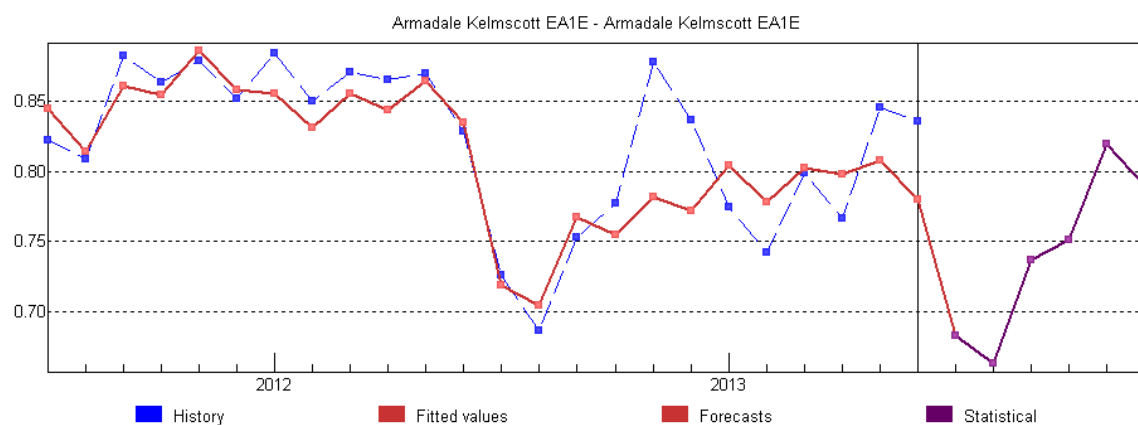
Triage category 4 (EA1D)

Figure 4-39: Armadale Kelmscott Hospital, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

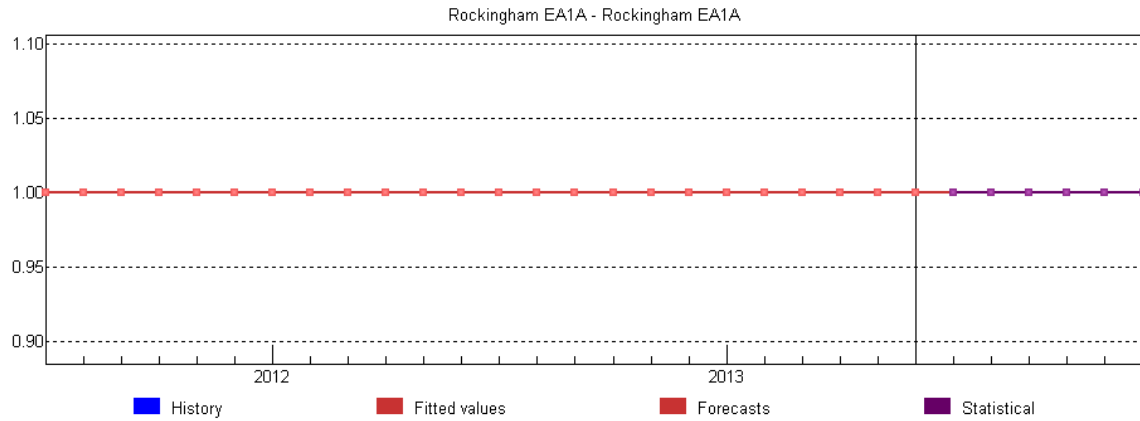
Figure 4-40: Armadale Kelmscott Hospital, July 2011 - June 2013: EA1E (Triage category 5)



Rockingham Hospital

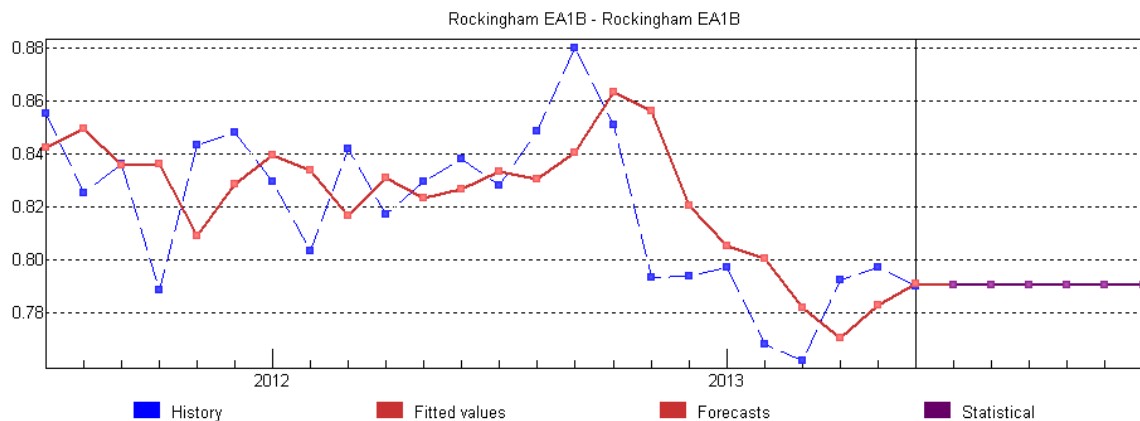
Triage category 1 (EA1A)

Figure 4-41: Rockingham Hospital, July 2011 - June 2013: EA1A (Triage category 1)



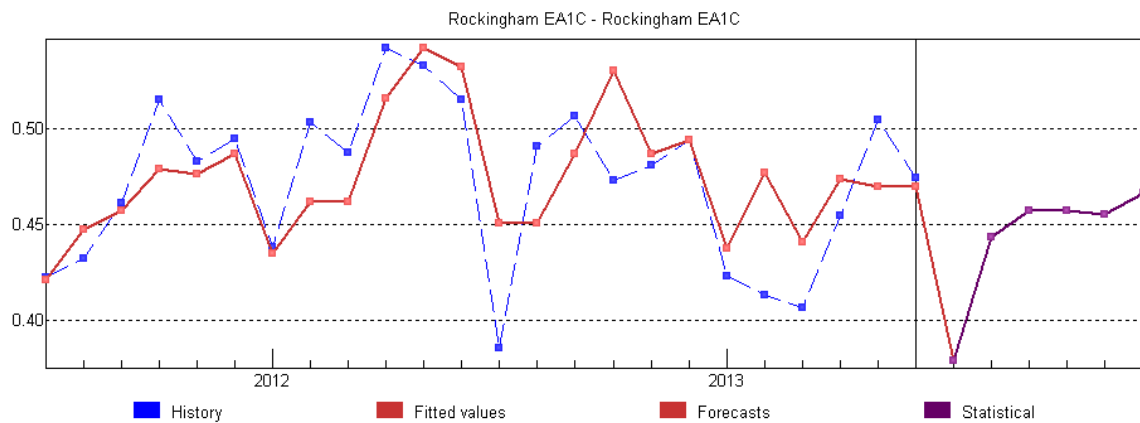
Triage category 2 (EA1B)

Figure 4-42: Rockingham Hospital, July 2011 - June 2013: EA1B (Triage category 2)



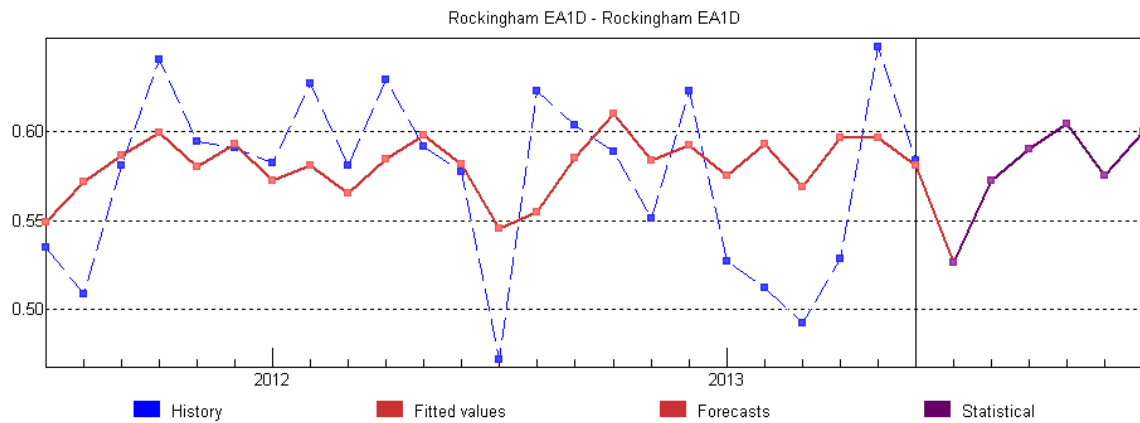
Triage category 3 (EA1C)

Figure 4-43: Rockingham Hospital, July 2011 - June 2013: EA1C (Triage category 3)



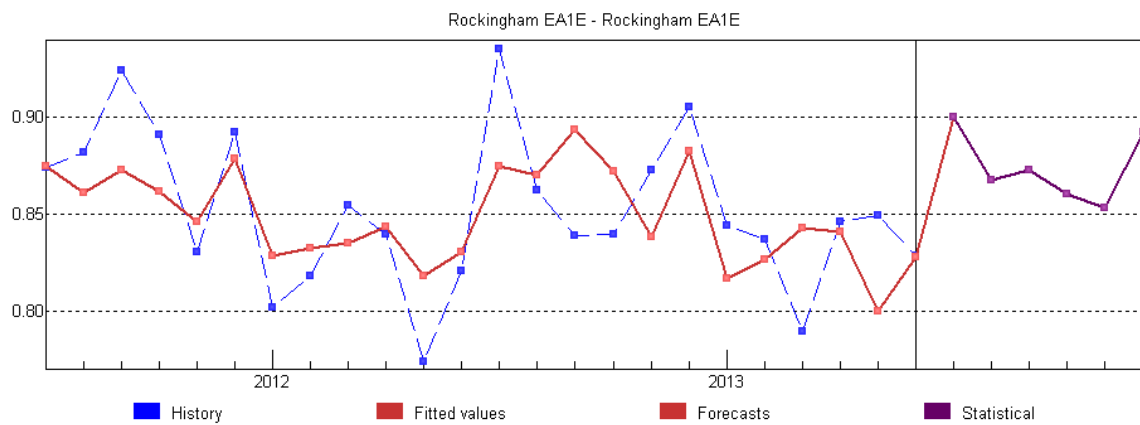
Triage category 4 (EA1D)

Figure 4-44: Rockingham Hospital, July 2011 - June 2013: EA1D (Triage category 4)



Triage category 5 (EA1E)

Figure 4-45: Rockingham Hospital, July 2011 - June 2013: EA1E (Triage category 5)



Appendix 5: Influenza like illnesses measures

Google flu trends: January 2006 – October 2012

Figure 5-1: Google flu trends & flu notifications, January 2006 – October 2012

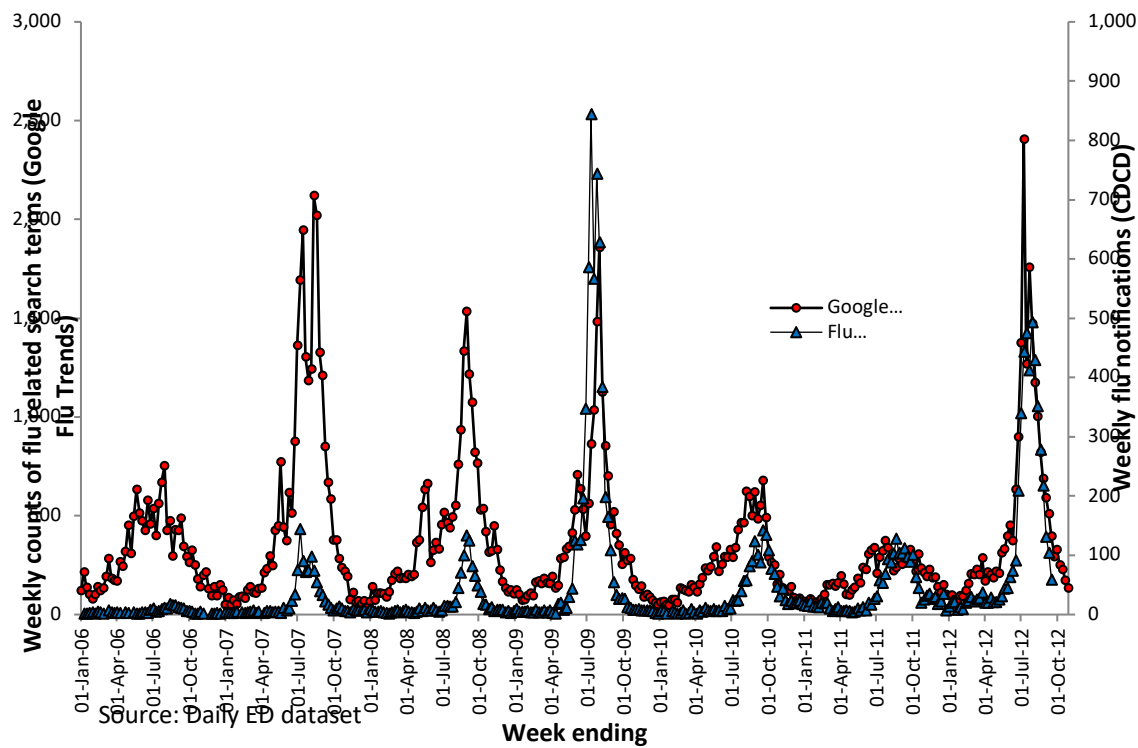


Figure 5-2: Google flu trends & respiratory viral presentations at EDs, January 2006 – October 2012

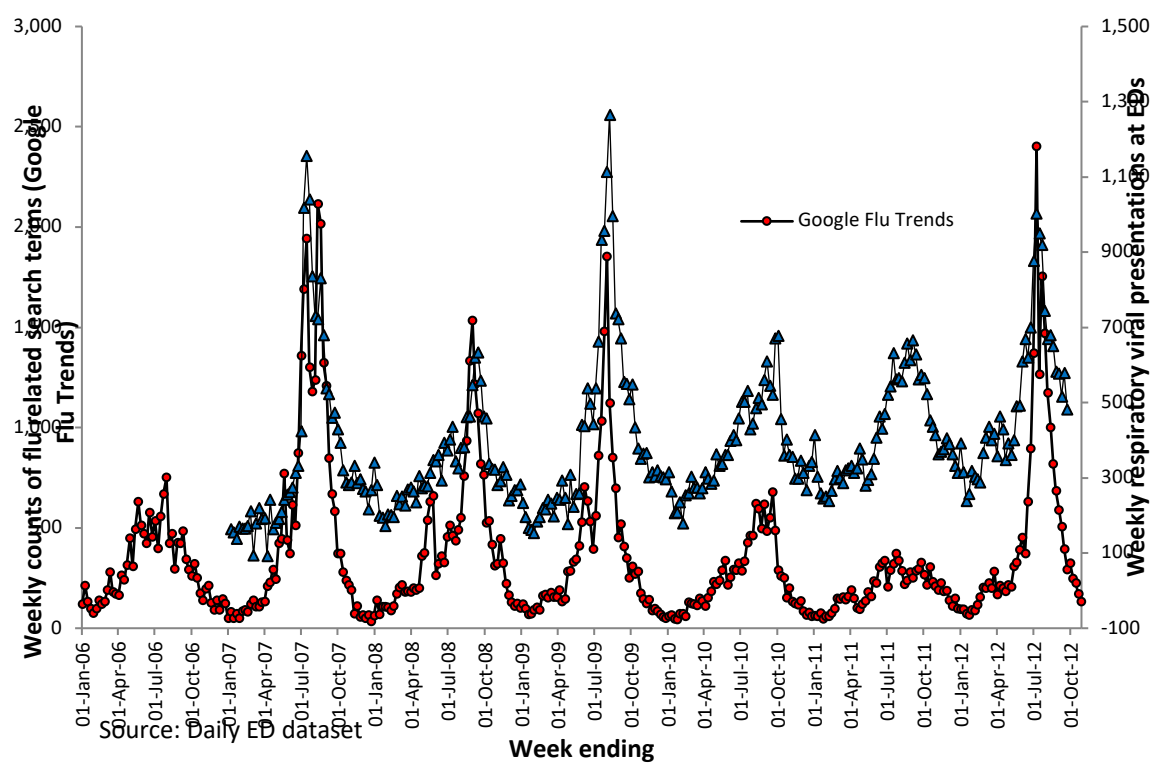
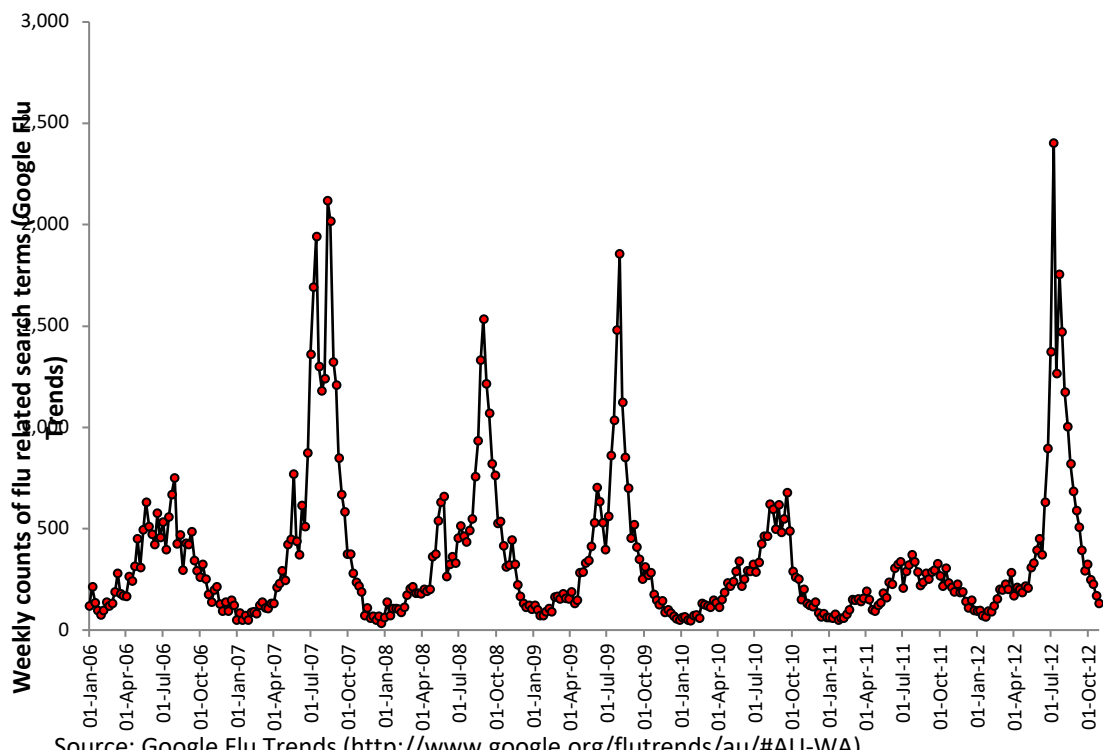


Figure 5-3: Google flu trends, January 2006 – October 2012



Daily maximum temperature: January 2006 – October 2012

Figure 5-4: Daily maximum temperature, Perth, January 2006 – October 2012

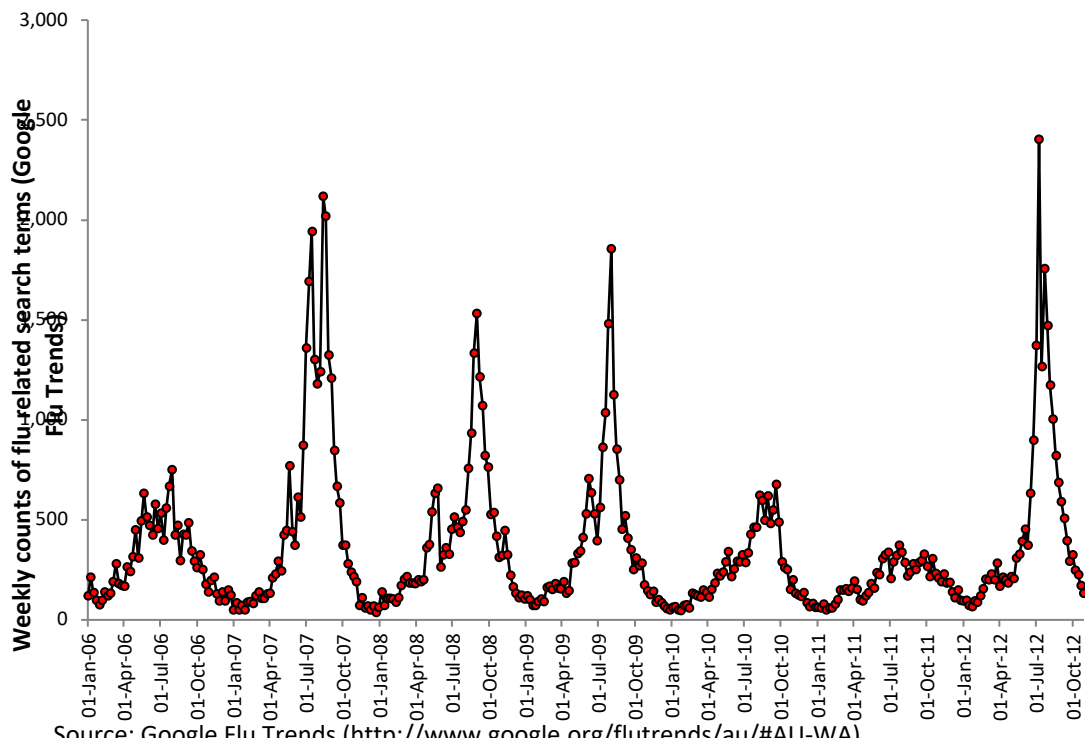
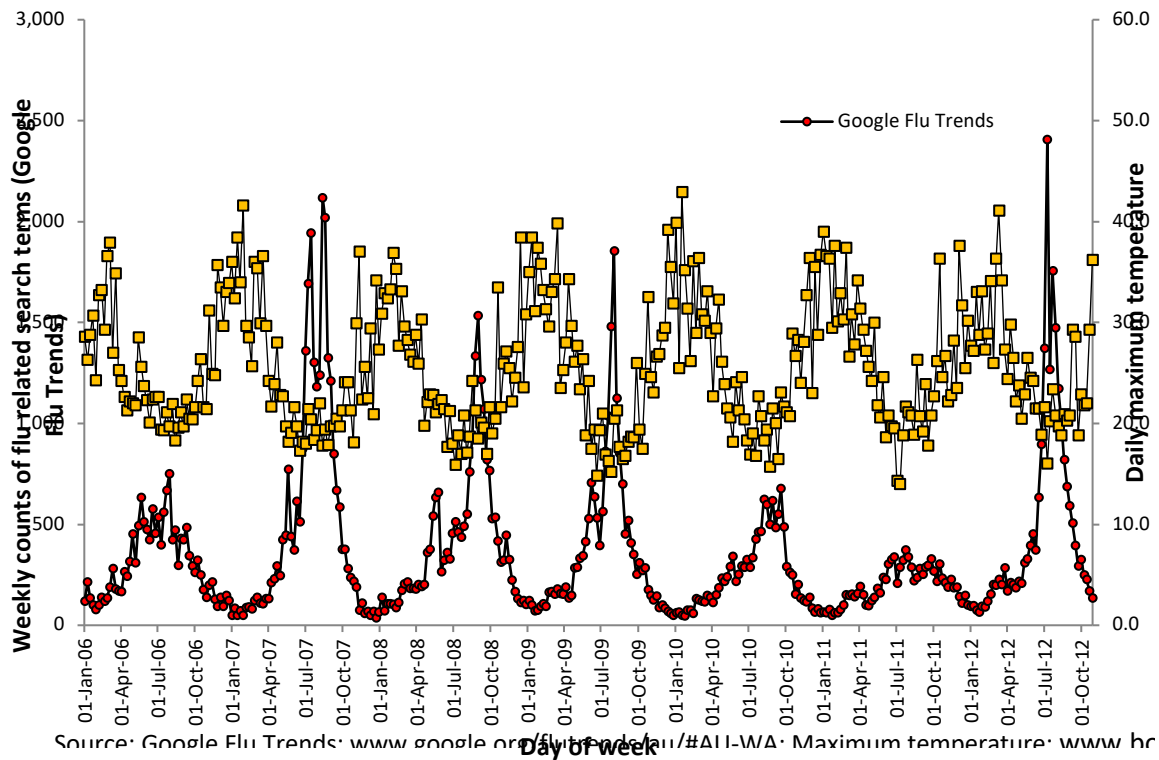


Figure 5-5: Google flu trends & daily maximum temperature, January 2006 – October 2012



Emergency department admissions: July 2006 – October 2012

Figure 5-6: ED admissions – all admissions & PMH admissions, July 2006 – October 2012

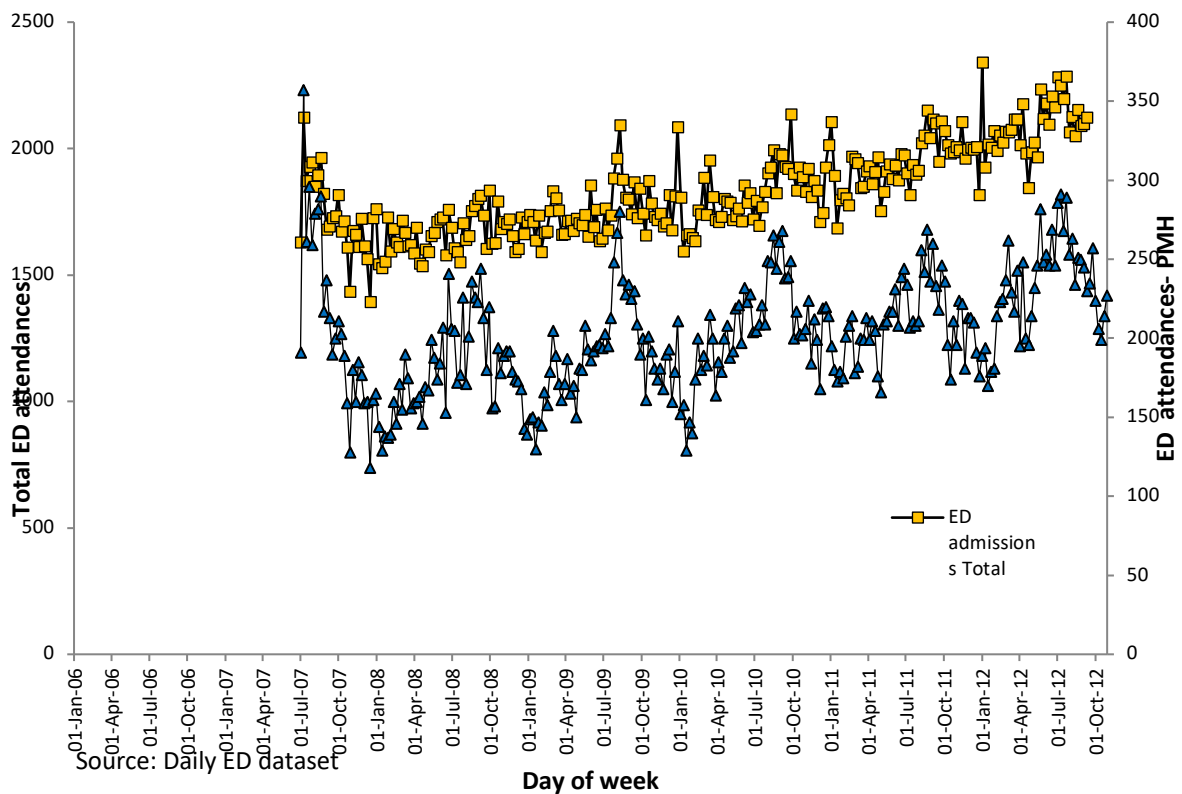


Figure 5-7: Daily maximum temperature & ED admissions, January 2006 – October 2012

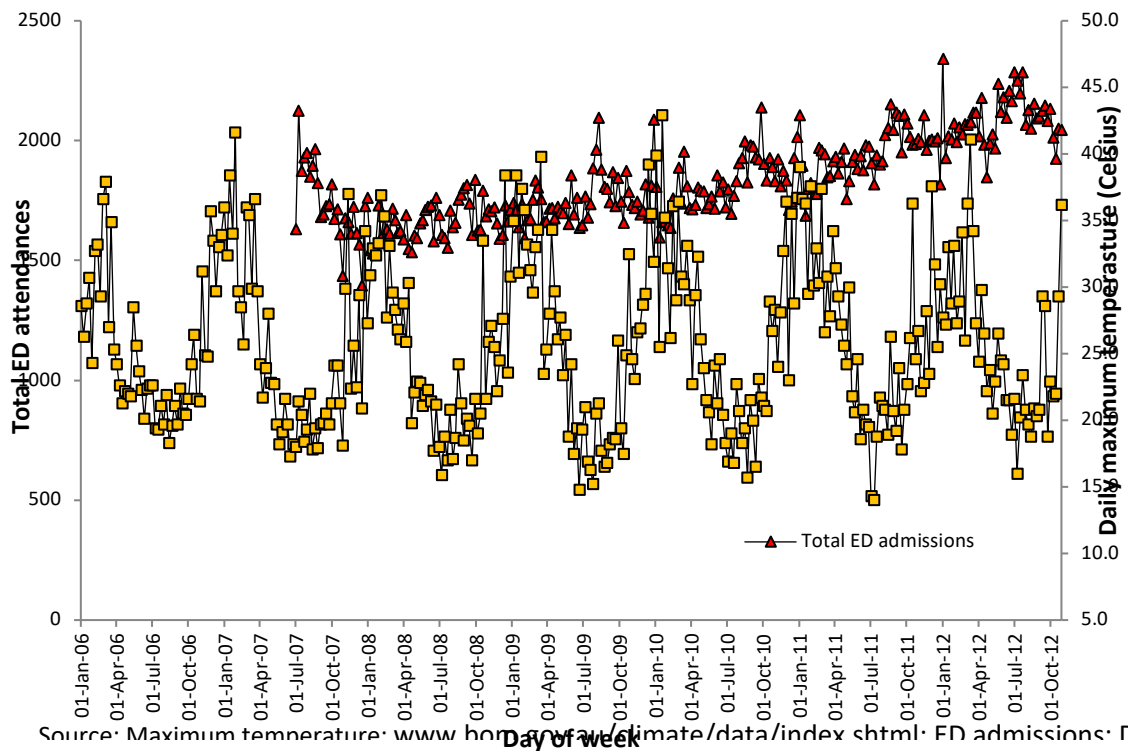


Figure 5-8: Daily maximum temperature & PMH ED admissions, January 2006 – October 2012

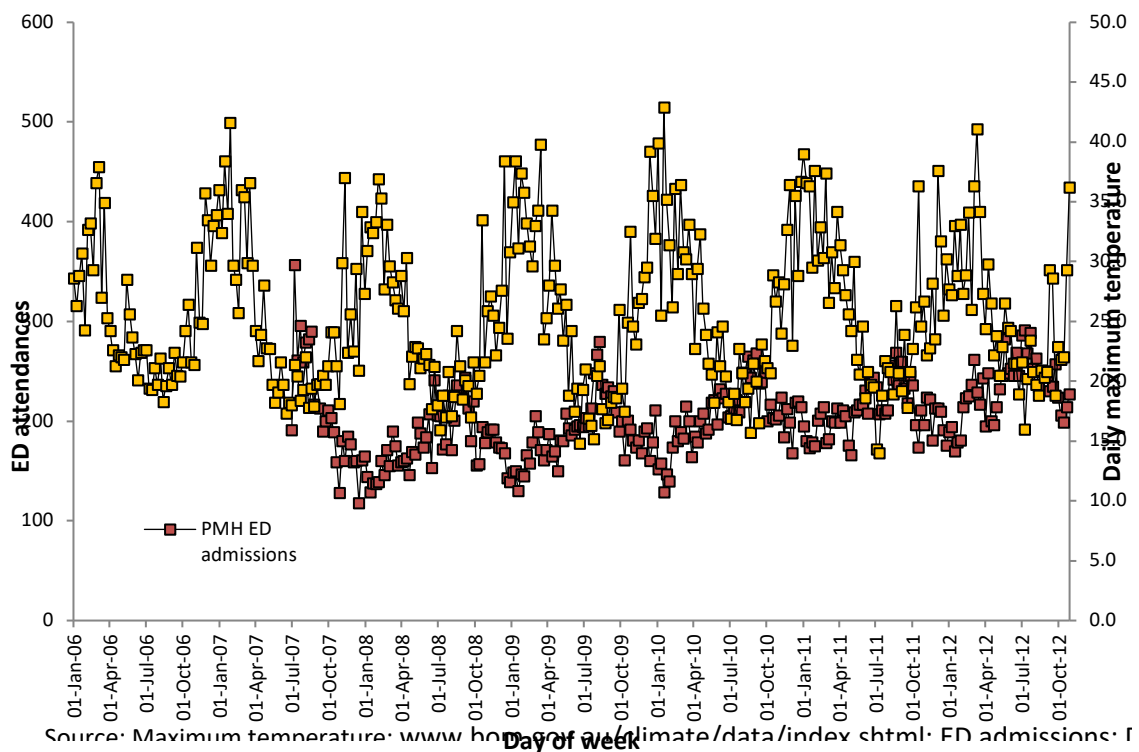


Figure 5-9: Daily maximum temperature & SCGH ED admissions, January 2006 – October 2012

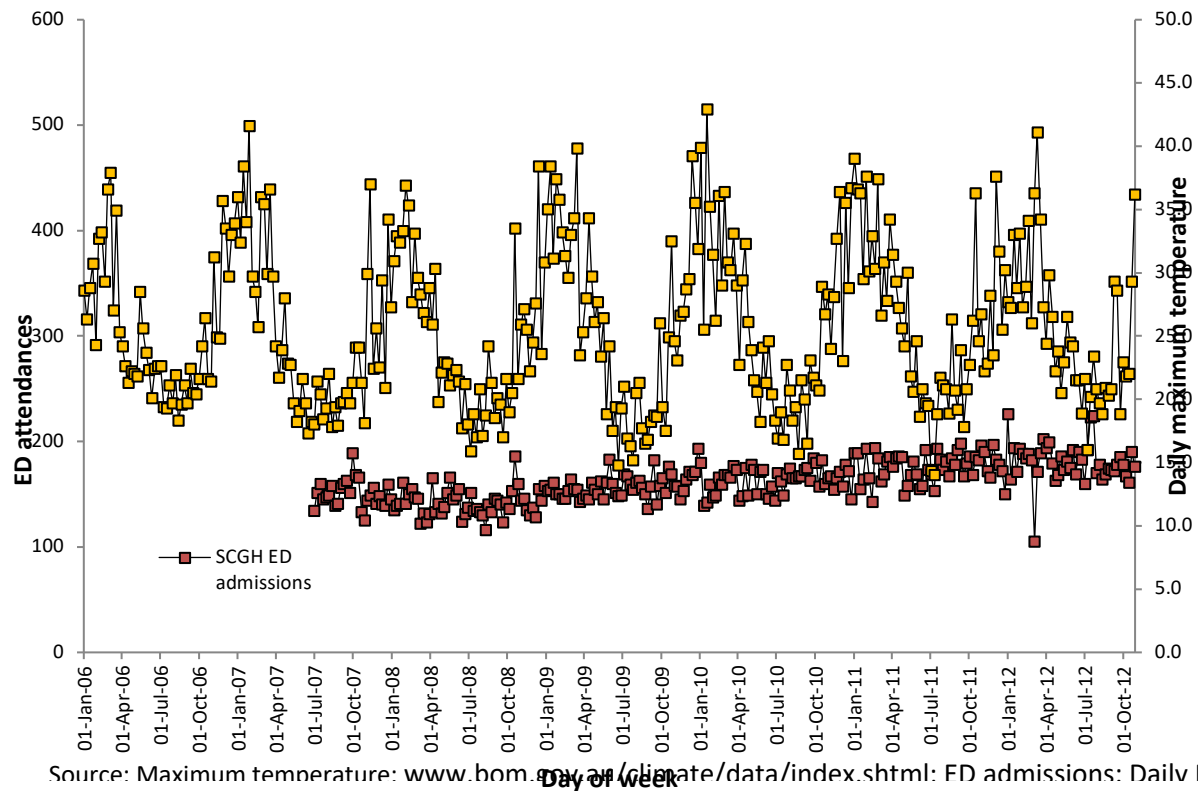


Figure 5-10: Google flu trends & total ED admissions, January 2006 – October 2012

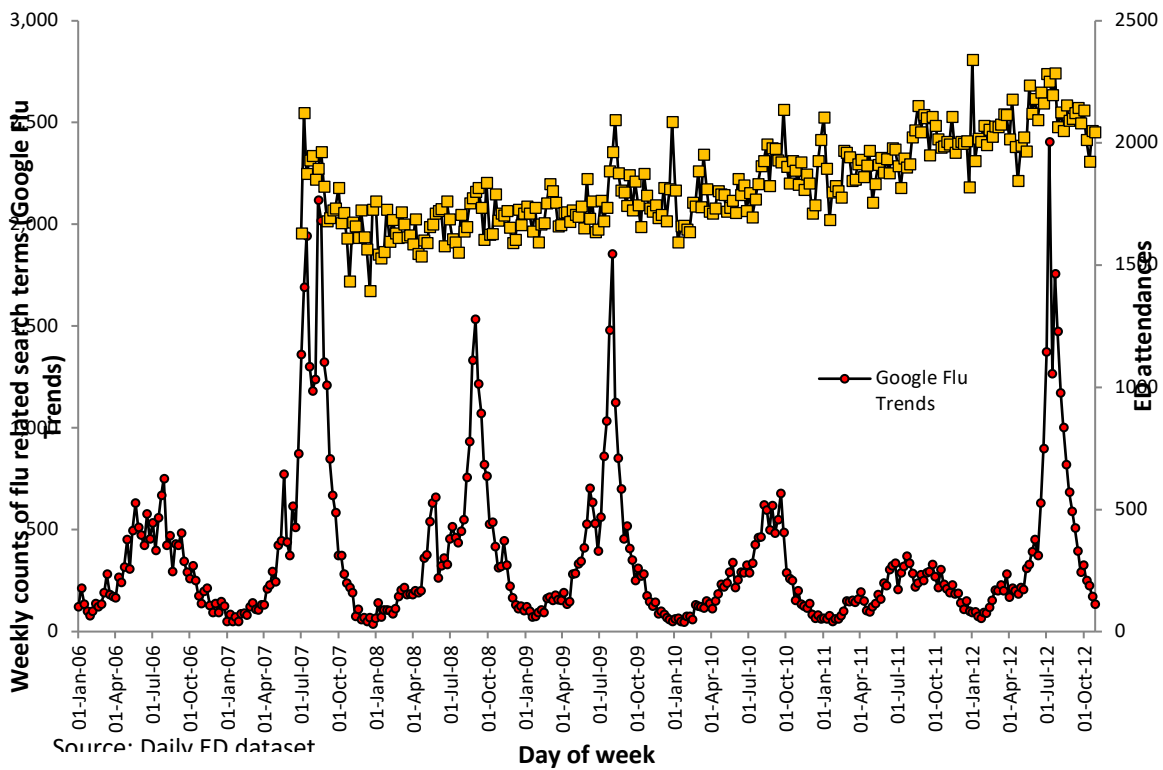


Figure 5-11: Google flu trends & PMH ED admissions, January 2006 – October 2012

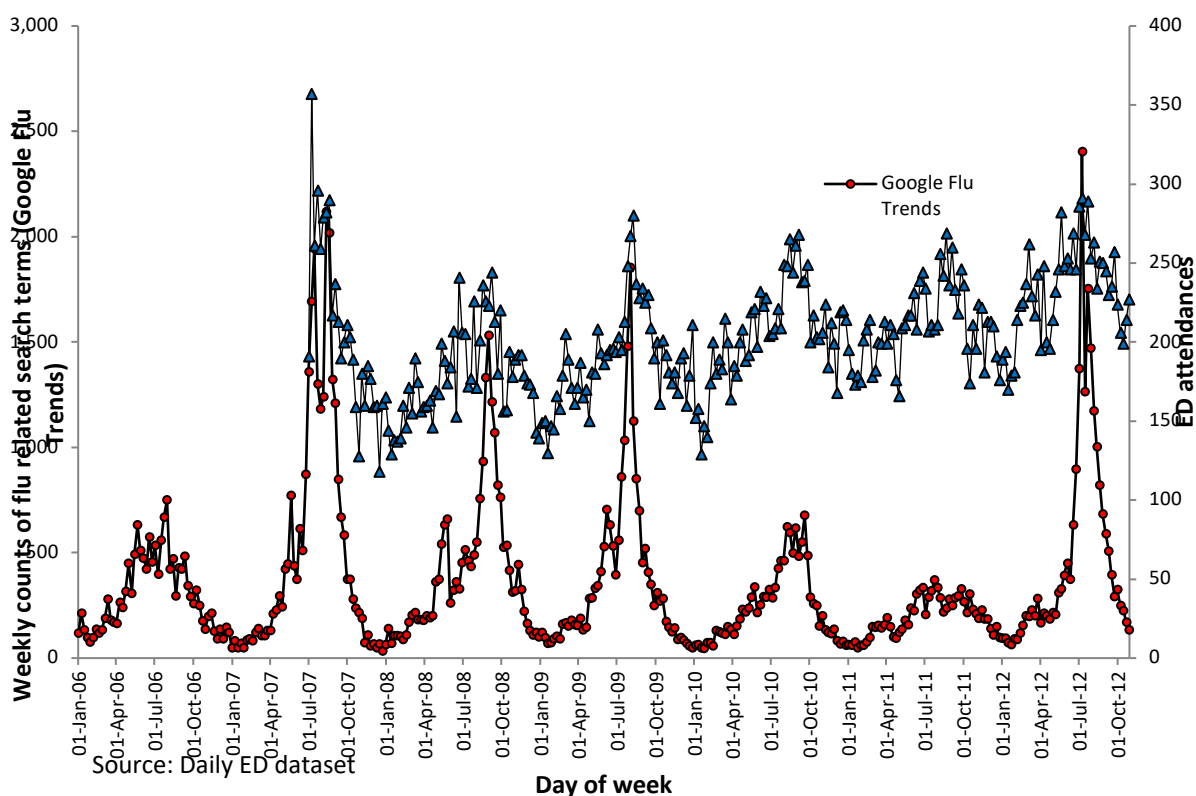
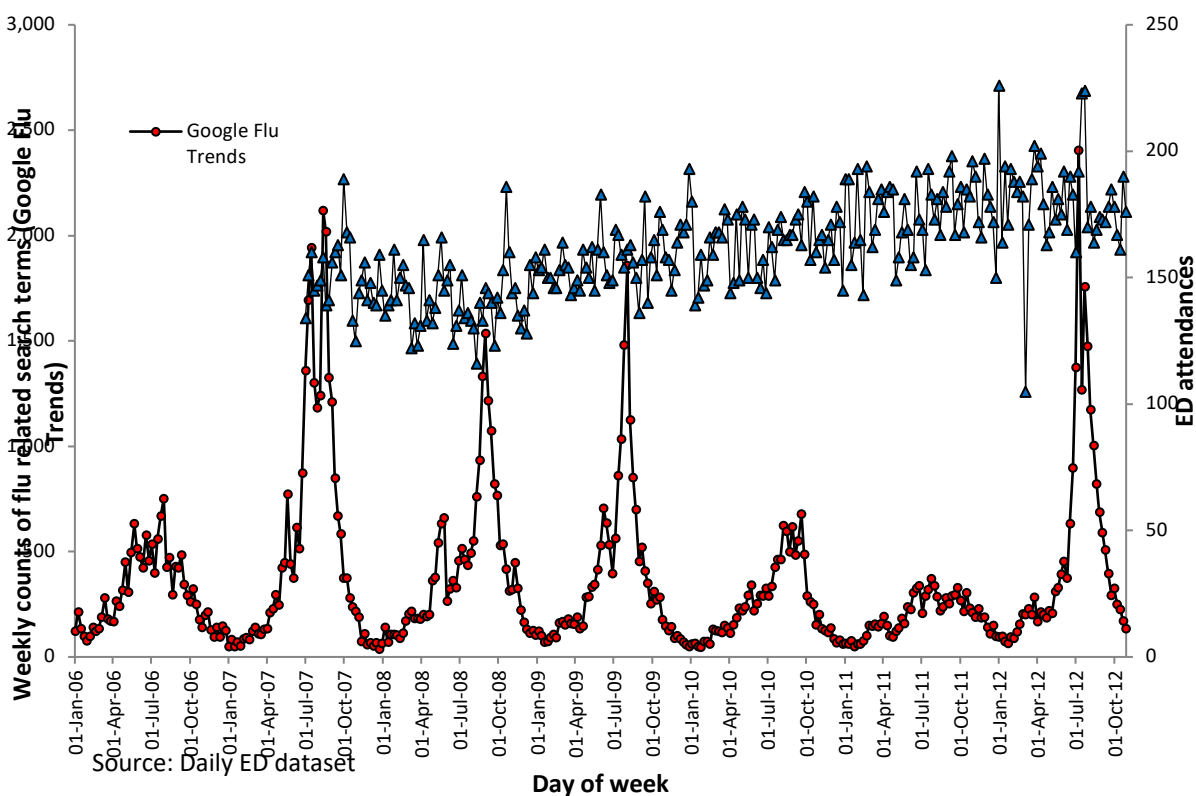


Figure 5-12: Google flu trends & SCGH ED admissions, January 2006 – October 2012



Health Direct flu related calls: January 2006 – October 2012

Figure 5-13: % weekly flu related calls handled by Health Direct & weekly flu notifications, January 2006 – October 2012

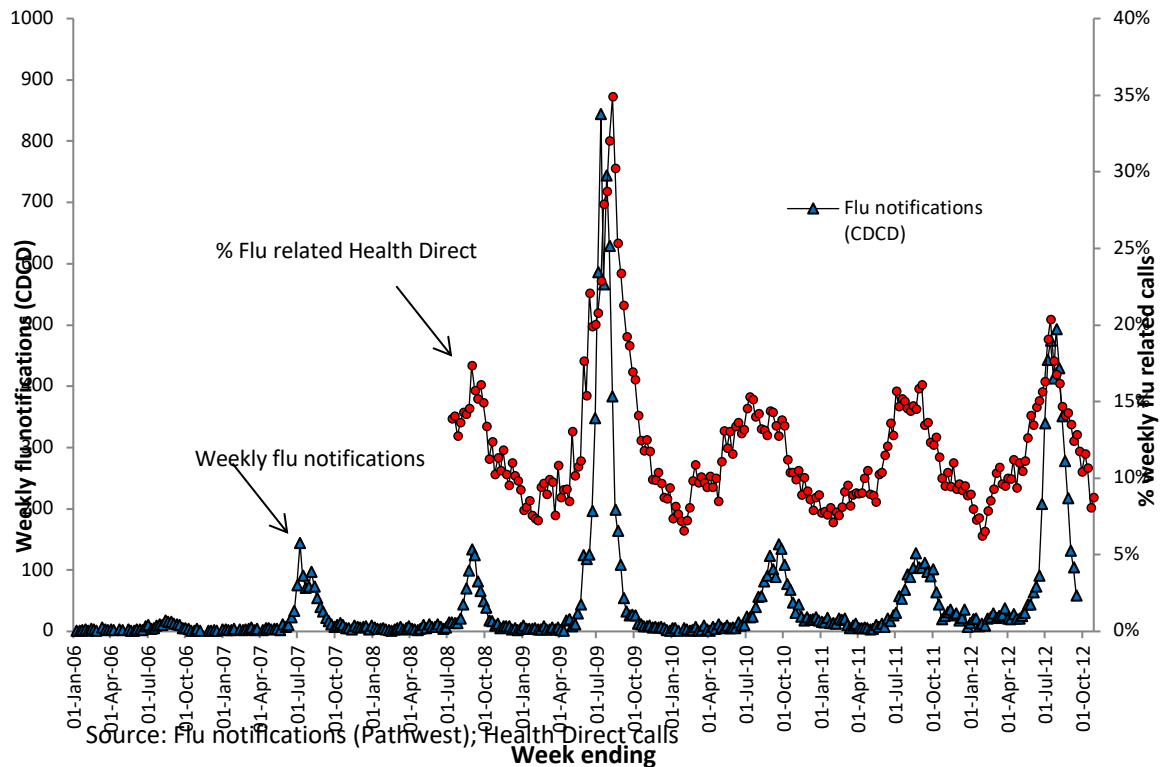


Figure 5-14: % weekly flu related calls handled by Health Direct & weekly Google flu trends, January 2006 – October 2012

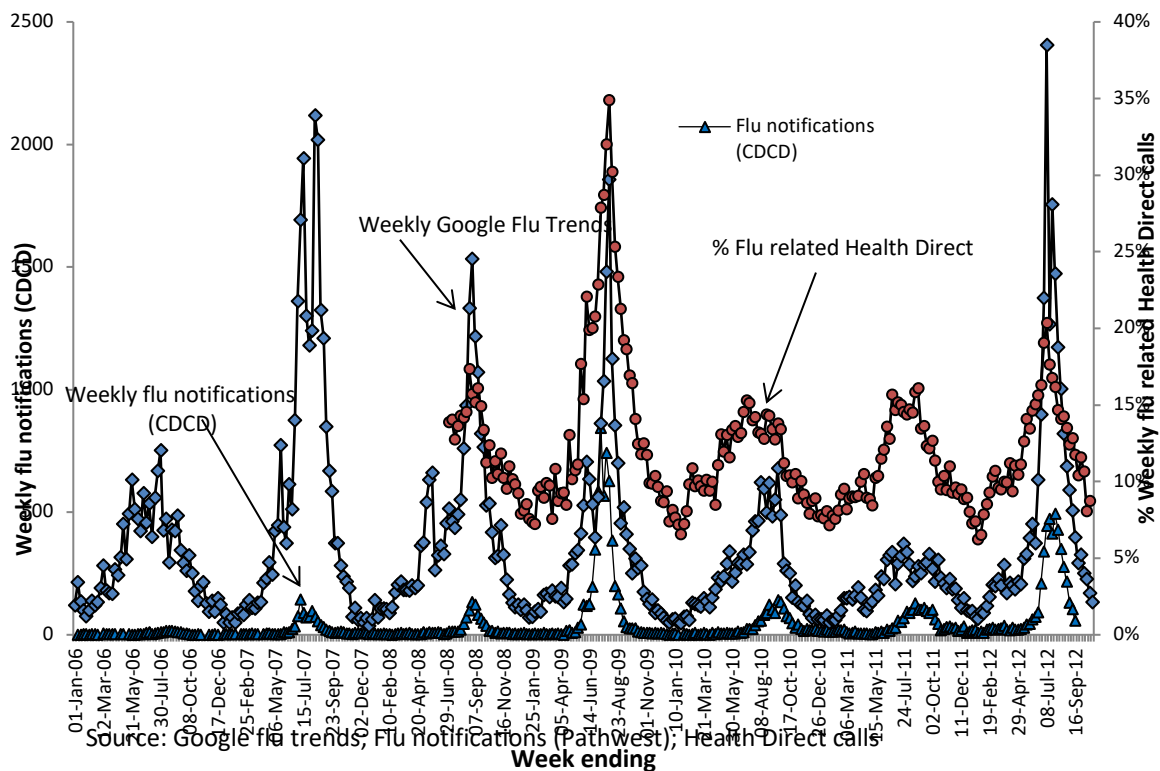


Figure 5-15: % weekly total calls handled by Health Direct - weekly flu related calls, % weekly flu related paediatric calls, January 2008 – October 2012

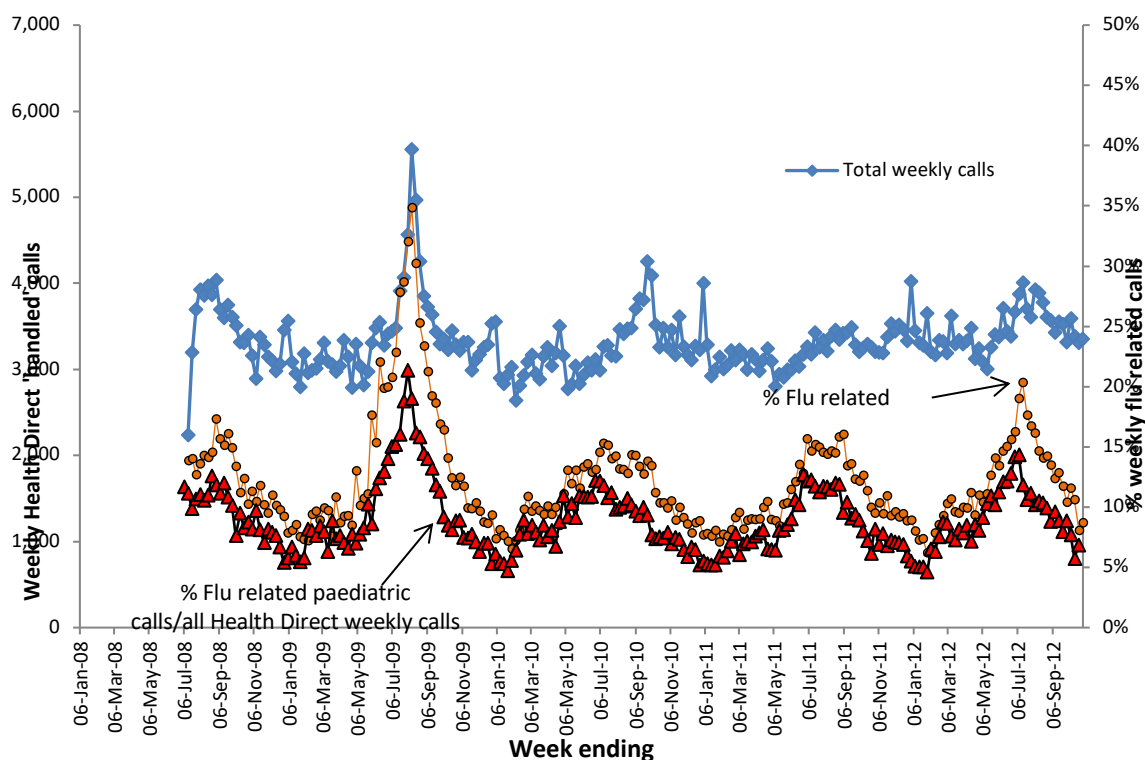
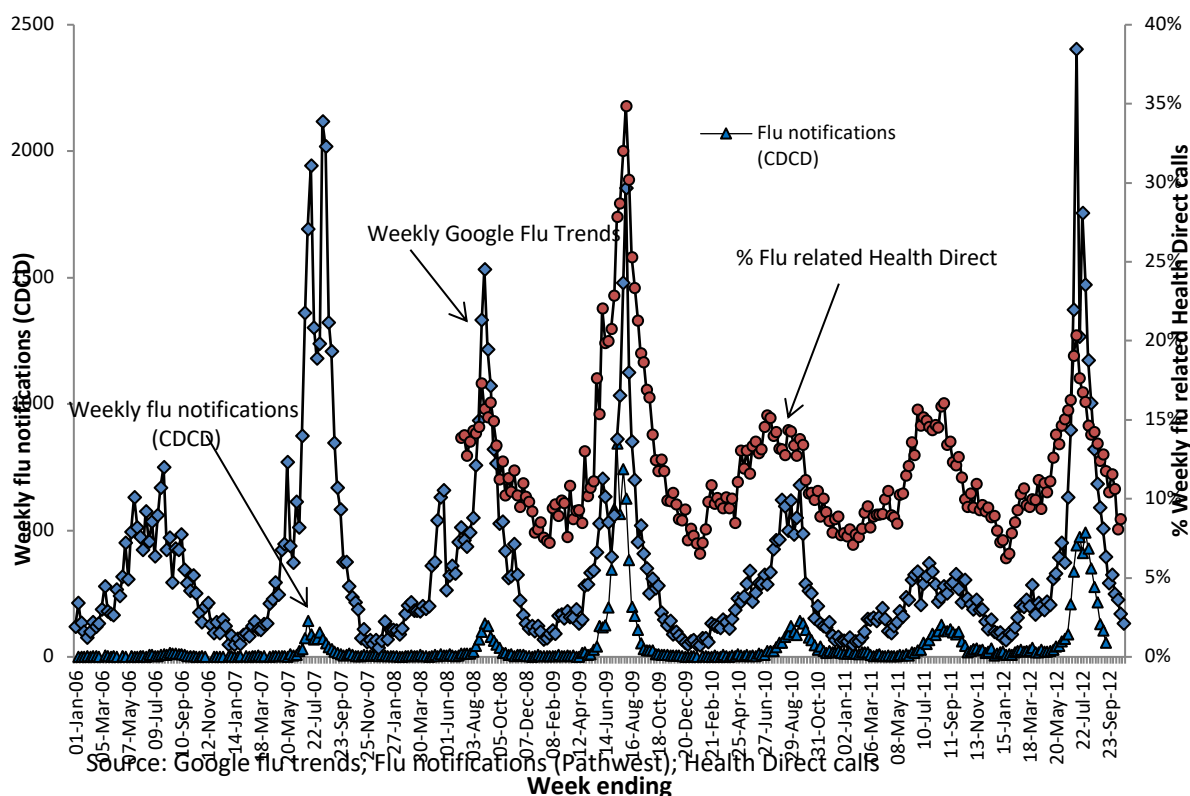


Figure 5-16: % weekly flu related call of total calls handled by Health Direct & weekly Google flu trend counts, January 2006 – October 2012



ED presentations: July 2007 – October 2012

Figure 5-17: % ILI presentations of all ED presentations, July 2007 – October 2012

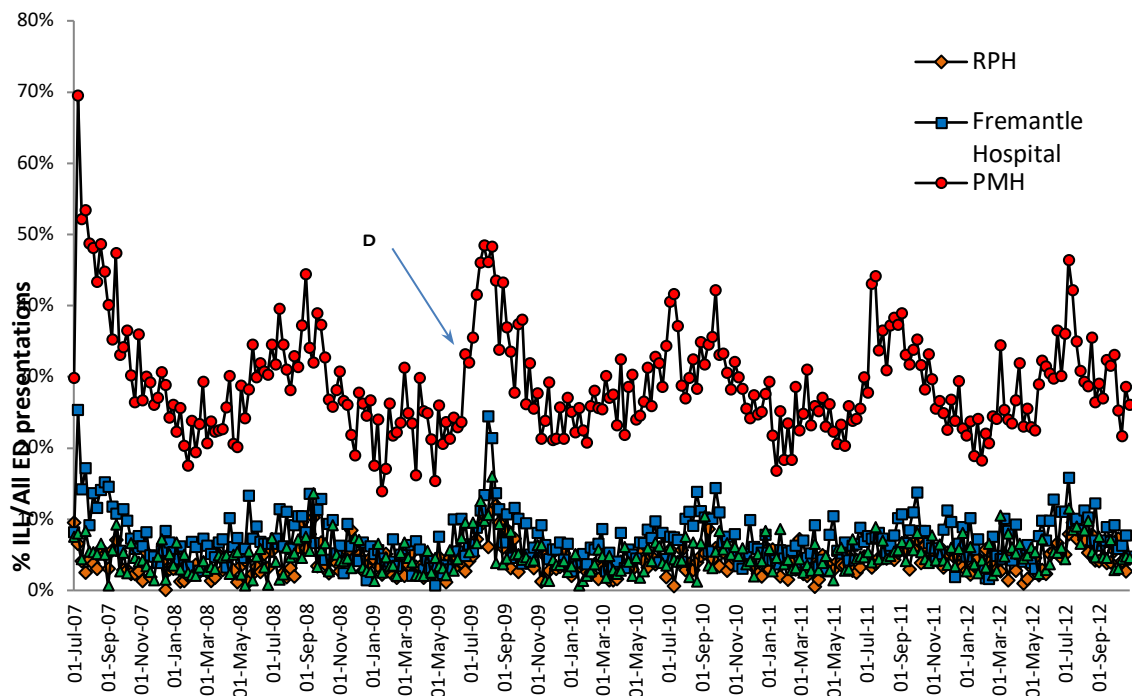


Figure 5-18: % ILI presentations of all ED presentations – outer , July 2007 – October 2012

