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Syndromic surveillance using mortality data: an example in dairy cattle

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INTRODUCTION & AIM

During the last decade public health communities put in place systems designed to monitor populations with the goal of improving the likelihood of disease outbreak being detected as early as possible. This kind of systems uses a set of nonspecific health related data, and was defined as Syndromic surveillance. On the basis of the same approach, aim of our study was to set up a syndromic surveillance system in North Western Italy (Piedmont) to capture outbreaks of anomalous cattle mortality.

MATERIALS AND METHODS

Data: individual dairy cattle dead since 01/01/2011 divided in 3 age classes (0-5 months, 6-24 months, over 24 months) (source: National Cattle Registry).
Software: STATA 13.1

STEP 1: Situational awareness

Historical data (2011-2013)

Comprehending the situation
- Descriptive statistics
- Removal of outliers (non parametric)
- Time series modeling (Poisson; ARIMA)

Projecting the situation
- Choice of the best model (Akaike Information Criteria)
- Application of the chosen model to achieve stationarity and normality of residuals

Outbreaks free baseline

Set up of statistical process control charts (SPC): Shewhart, EWMA

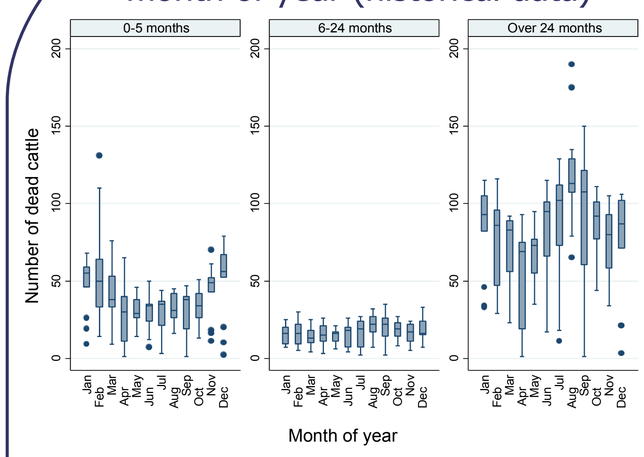
STEP 2: Early event detection

Weekly ongoing data

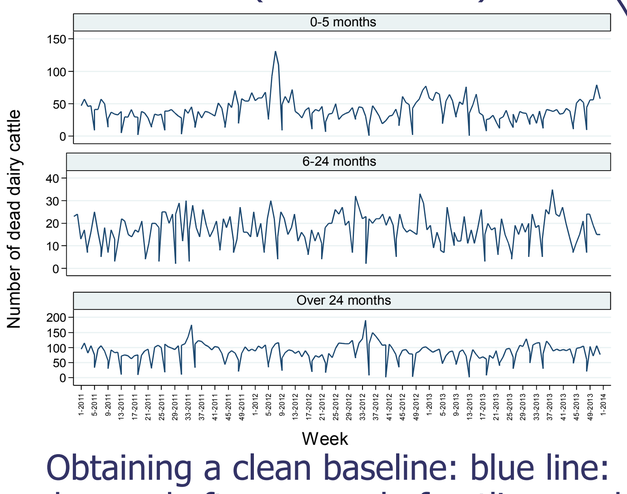
Application of SPC
- Visualisation of alarms
- Weekly automatic report

RESULTS

Number of dead dairy cattle by month of year (historical data)



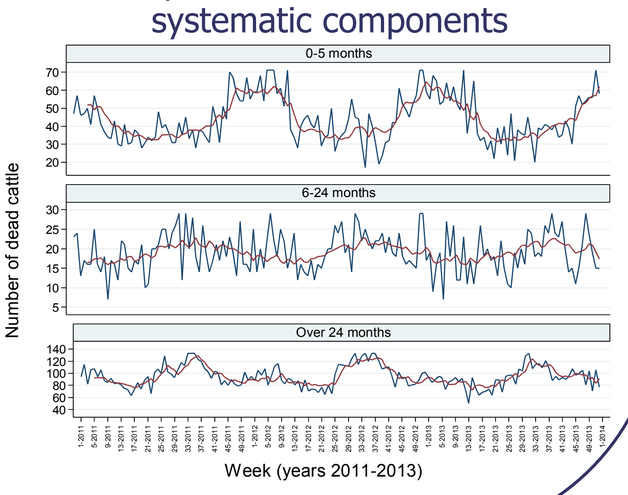
Weekly number of dead dairy cattle (historical data)



Selecting the model with the lowest AIC

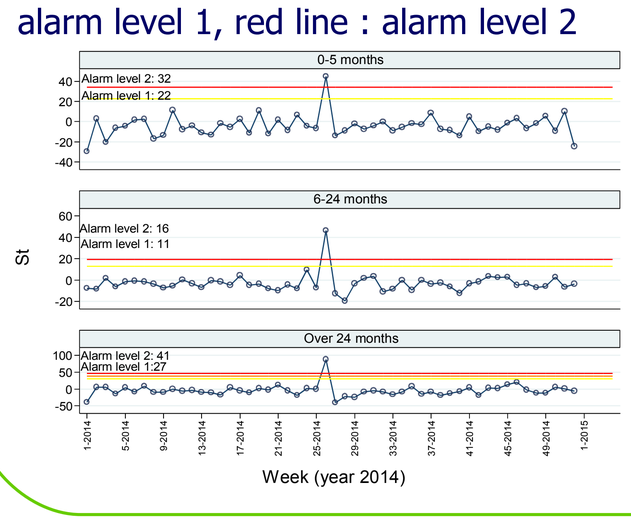
Model	Akaike Information Criteria 0-5 months	6-24 months	Over 24 months
Year	1456.048	964.6546	1515.384
Year+Lag1	1230.214	954.8944	1283.253
Year+Lag1+Lag2	1189.535	946.169	1243.267
Year+Lag1+Lag2+Lag3	1179.141	940.1211	1231.104
Year+Lag1+Lag2+Lag3+Lag4	1173.153	936.7701	1224.848
Cos(time)+Sin(time)	1189.591	944.3238	1343.893
Cos(time)+Sin(time)+Lag1	1157.434	939.3002	1256.724
Cos(time)+Sin(time)+Lag1+Lag2	1145.499	933.5197	1227.534
Cos(time)+Sin(time)+Lag1+Lag2+Lag3	1138.725	929.2522	1219.112
Cos(time)+Sin(time)+Lag1+Lag2+Lag3+Lag4	1133.187	924.5909	1211.088
Week	1459.621	964.6229	1520.073
Week+Lag1	1229.902	954.733	1283.983
Week+Lag1+Lag2	1188.465	954.9115	1243.411
Week+Lag1+Lag2+Lag3	1178.03	940.253	1231.386
Week+Lag1+Lag2+Lag3+Lag4	1171.959	937.0084	1225.085
ARIMA(1,0,0)	-	953.3683	-
ARIMA(2,0,0)	-	951.6689	1238.921
ARIMA(2,0,4)	1158.024	-	-
ARIMA(2,0,5)	1138.89	-	-
ARIMA(3,0,0)	-	953.3462	1237.921
ARIMA(3,0,1)	-	953.7845	1239.713
ARIMA(3,0,3)	-	-	1232.221

Obtaining a clean baseline: blue line: observed after removal of outliers, red line:predicted after removal of systematic components

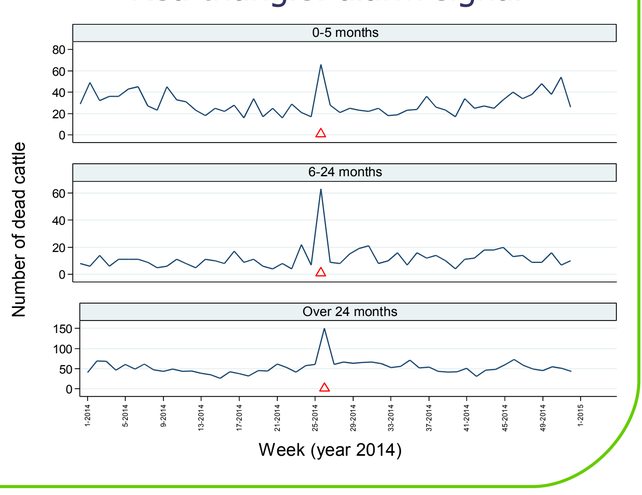


Alarm visualisation with one simulated outbreak in week 26-2014

Shewhart Chart on residuals. Yellow line alarm level 1, red line : alarm level 2



EWMA (λ=0.4) on residuals. Red triangle: alarm signal



CONCLUSION

- Three age class were chosen assuming different effects of months on number of deaths
- The chosen model is able to smooth peaks and to remove systematic components (e.g. cyclic, seasonal,..)
- Both Shewhart and EWMA raised an alarm when the number of deaths doubled in week 26-2014 (outbreak simulation)

POINTS OF DISCUSSION

- Critical points:
  - Timeliness of data
  - Absence of denominator
  - Appropriate setting of SPC
- Further development:
  - Early event detection evaluation through outbreak simulation
  - Spatial visualisation of mortality (provincial level)

Bibliography

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