Monitoring endemic livestock diseases using laboratory diagnostic data: A simulation study to evaluate the performance of univariate process monitoring control algorithms - DTU Orbit (11/12/2018)

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Surveillance systems are critical for accurate, timely monitoring and effective disease control. In this study, we investigated the performance of univariate process monitoring control algorithms in detecting changes in seroprevalence for endemic diseases. We also assessed the effect of sample size (number of sentinel herds tested in the surveillance system) on the performance of the algorithms.

Three univariate process monitoring control algorithms were compared: Shewart p Chart 1 (PSHEW), Cumulative Sum 2 (CUSUM) and Exponentially Weighted Moving Average 3 (EWMA). Increases in seroprevalence were simulated from 0.10 to 0.15 and 0.20 over 4, 8, 24, 52 and 104 weeks. Each epidemic scenario was run with 2000 iterations. The cumulative sensitivity 4 (CumSe) and timeliness were used to evaluate the algorithms’ performance with a 1% false alarm rate. Using these performance evaluation criteria, it was possible to assess the accuracy and timeliness of the surveillance system working in real-time.

The results showed that EWMA and PSHEW had higher CumSe (when compared with the CUSUM) from week 1 until the end of the period for all simulated scenarios. Changes in seroprevalence from 0.10 to 0.20 were more easily detected (higher CumSe) than changes from 0.10 to 0.15 for all three algorithms. Similar results were found with EWMA and PSHEW, based on the median time to detection. Changes in the seroprevalence were detected later with CUSUM, compared to EWMA and PSHEW for the different scenarios. Increasing the sample size 10 fold halved the time to detection (CumSe = 1), whereas increasing the sample size 100 fold reduced the time to detection by a factor of 6.

This study investigated the performance of three univariate process monitoring control algorithms in monitoring endemic diseases. It was shown that automated systems based on these detection methods identified changes in seroprevalence at different times. Increasing the number of tested herds would lead to faster detection. However, the practical implications of increasing the sample size (such as the costs associated with the disease) should also be taken into account.

General information
State: Published
Organisations: National Veterinary Institute, Section for Epidemiology, National Veterinary Institute
Contributors: Lopes Antunes, A. C., Dorea, F., Hisham Beshara Halasa, T., Toft, N.
Pages: 15-20
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Preventive Veterinary Medicine
Volume: 127
ISSN (Print): 0167-5877
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.26 SJR 1.144 SNIP 1.31
Web of Science (2017): Impact factor 1.924
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.2 SJR 1.249 SNIP 1.361
Web of Science (2016): Impact factor 1.987
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.1 SJR 1.282 SNIP 1.177
Web of Science (2015): Impact factor 2.182
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.37 SJR 1.27 SNIP 1.407
Web of Science (2014): Impact factor 2.167
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.49 SJR 1.264 SNIP 1.529
Web of Science (2013): Impact factor 2.506
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.45 SJR 1.265 SNIP 1.436
Web of Science (2012): Impact factor 2.389
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.24 SJR 1.194 SNIP 1.295
Web of Science (2011): Impact factor 2.046
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.156 SNIP 1.284
Web of Science (2010): Impact factor 2.07
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.032 SNIP 1.338
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.056 SNIP 1.258
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.009 SNIP 1.353
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.06 SNIP 1.277
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.931 SNIP 1.414
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.812 SNIP 1.146
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.846 SNIP 1.323
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.857 SNIP 1.427
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.045 SNIP 1.48
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.623 SNIP 1.261
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.647 SNIP 1.005
Original language: English
Keywords: Endemic disease, Laboratory results, Univariate process monitoring control algorithms
DOIs:
10.1016/j.prevetmed.2016.03.005
Source: PublicationPreSubmission
Source-ID: 122380327
Research output: Research - peer-review › Journal article – Annual report year: 2016