Supplementary Material for Chapter 5

Tables

	Perfect Test	90% Sensitive & 90% Specific RDT						
Rank	All Noise	1x Poisson Noise	7x Poisson Noise	1x Dynamical Noise	7x Dynamical Noise			
1	Variance (0.62)	Variance (0.61)	Variance (0.6)	Variance (0.66)	Index of dispersion (0.47)			
2	Index of dispersion (0.58)	Index of dispersion (0.59)	Index of dispersion (0.6)	Autocovariance (0.63)	Autocorrelation (0.45)			
3	Autocovariance (0.58)	Autocovariance (0.55)	Coefficient of variation (0.59)	Index of dispersion (0.57)	Coefficient of variation (0.45)			
4	Autocorrelation (0.38)	Coefficient of variation (0.51)	Autocovariance (0.51)	Mean (0.48)	Autocovariance (0.39)			
5	Mean (0.38)	Autocorrelation (0.41)	Mean (0.37)	Autocorrelation (0.42)	Variance (0.38)			
6	Coefficient of variation (0.15)	Mean (0.35)	Autocorrelation (0.36)	Coefficient of variation (0.12)	Skewness (0.11)			
7	Skewness (0.06)	Skewness (0.14)	Skewness (0.1)	Skewness (-0.05)	Kurtosis (-0.19)			
8 Kurtosis (-0.02) I		Kurtosis (0.01)	Kurtosis (0.02)	Kurtosis (-0.11)	Mean (-0.21)			

Table 1: The ranking and mean value of Kendall's Tau computed on the subset of the emergent time series after the burn-in period, for a perfect test and an RDT with 90% sensitivity and 90% specificity, under high and low Poisson and dynamical noise systems

	Perfect Test	90% Sensitive & 90% Specific RDT					
Rank	All Noise	1x Poisson Noise	7x Poisson Noise	1x Dynamical Noise	7x Dynamical Noise		
1	Autocovariance (0.7)	Autocovariance (0.73)	Autocovariance (0.72)	Autocovariance (0.66)	Mean (0.55)		
2	Variance (0.7)	Variance (0.71)	Mean (0.7)	Variance (0.64)	Variance (0.54)		
3	Mean (0.68) Mean (0.7)		Variance (0.68)	Mean (0.63)	Autocovariance (0.53)		
4	Index of dispersion (0.63)	Index of dispersion (0.67)	Index of dispersion (0.68)	Index of dispersion (0.59)	Skewness (0.51)		
5	Autocorrelation (0.62)	Autocorrelation (0.67)	Coefficient of variation (0.67)	Autocorrelation (0.57)	Kurtosis (0.51)		
6	Skewness (0.6)	Coefficient of variation (0.6)	Autocorrelation (0.66)	Skewness (0.56)	Index of dispersion (0.5)		
7	Kurtosis (0.53)	Skewness (0.58)	Skewness (0.6)	Kurtosis (0.51)	Autocorrelation (0.49)		
8	Coefficient of variation (0.39)	Kurtosis (0.45)	Kurtosis (0.57)	Coefficient of variation (0.45)	Coefficient of variation (0.48)		

Table 2: The ranking of AUC computed on the subset of the emergent time series after the burn-in period, for a perfect test and an RDT with 90% sensitivity and 90% specificity, under high and low Poisson and dynamical noise systems

	Perfec	ct Test	90% Sensitive & 90% Specific RDT						
Rank	All Noise -	All Noise -	1x Poisson	7x Poisson	1x	7x			
Kank	AUC-0.5	Accuracy	Noise	Noise	Dynamical	Dynamical			
					Noise	Noise			
1	Autocovariance Mean (0.72)		Mean (0.73)	Variance	Variance	Mean (0.6)			
	(0.2)			(0.73)	(0.68)				
2	Variance Variance		Variance	Coefficient	Mean (0.66)	Skewness			
	(0.2)	(0.72)	(0.7)	of variation		(0.57)			
			(0.72)						
3	Mean (0.18) Autocovariance		Autocovariance	Mean (0.72)	Autocovariance	Kurtosis			
		(0.7)	(0.7)		(0.65)	(0.55)			
4	Index of	Index of	Index of	Index of	Skewness	Autocorrelation			
	dispersion	dispersion	dispersion	dispersion	(0.6)	(0.54)			
	(0.13)	(0.63)	(0.69)	(0.72)					
5	AutocorrelationAutocorrelation		Autocorrelation	Autocovariance	Index of	Autocovariance			
	(0.12) (0.62)		(0.67) (0.71)		dispersion	(0.52)			
					(0.6)				
6	Coefficient	Skewness	Coefficient	Autocorrelation	Kurtosis	Coefficient			
	of variation	(0.6)	of variation	(0.66)	(0.57)	of variation			
	(0.11)		(0.66)			(0.52)			
7	Skewness	Kurtosis	Skewness	Skewness	Autocorrelation	Variance			
	(0.1)	(0.58)	(0.62)	(0.66)	(0.55)	(0.52)			
8	Kurtosis Coefficient Kurto		Kurtosis	Kurtosis	Coefficient	Index of			
	(0.03) of variation		(0.56)	(0.57)	of variation	dispersion			
	(0.5)				(0.51)	(0.51)			

Table 3: The ranking and $|{\rm AUC}-0.5|$ for each metric computed on the emergent time series with a perfect test, and the alert accuracy with an RDT. The values are computed on the full time series, and the subset from after the completion of the burn-in period, with a perfect test

Plots

AUC Magnitude Heatmaps

After 5yr Burn in

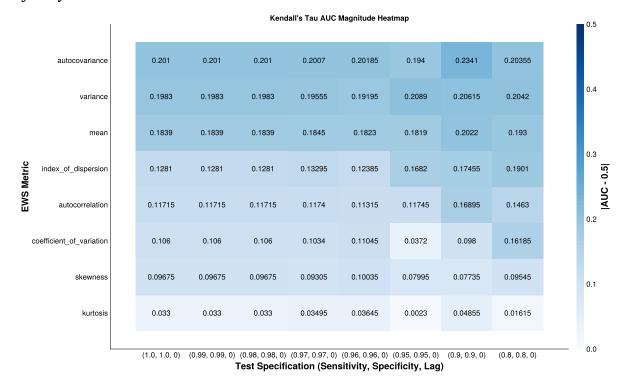


Figure 1: Poisson noise, 1x

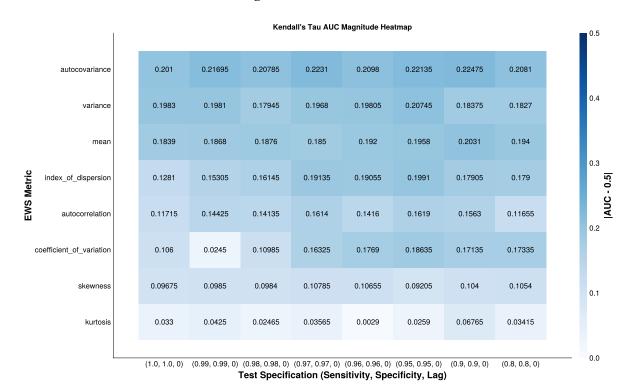


Figure 2: Poisson noise, 7x

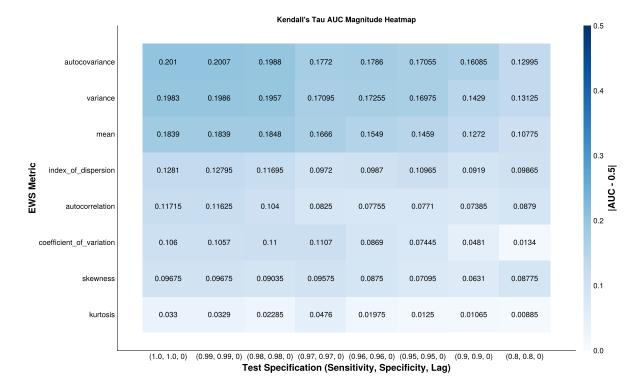


Figure 3: Dynamical noise, 1x

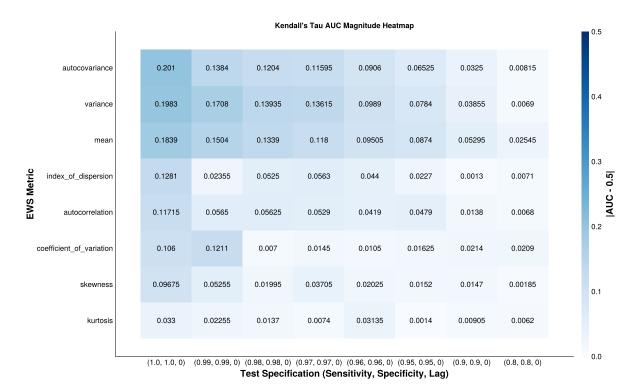


Figure 4: Dynamical noise, 7x

AUC Heatmaps

After 5yr Burn in

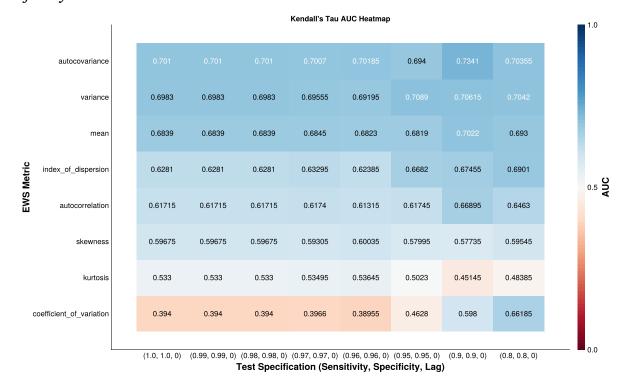


Figure 5: Poisson noise, 1x



Figure 6: Poisson noise, 7x

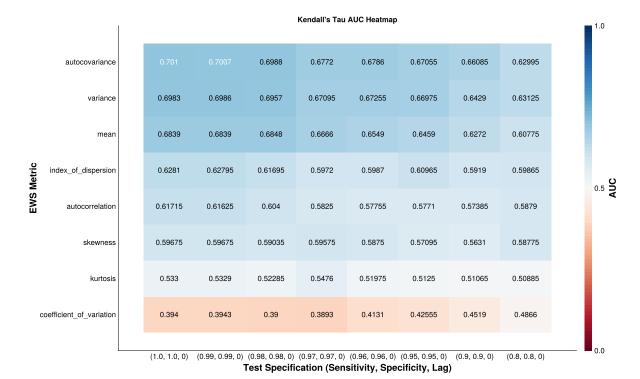


Figure 7: Dynamical noise, 1x



Figure 8: Dynamical noise, 7x

Optimal Threshold Accuracies

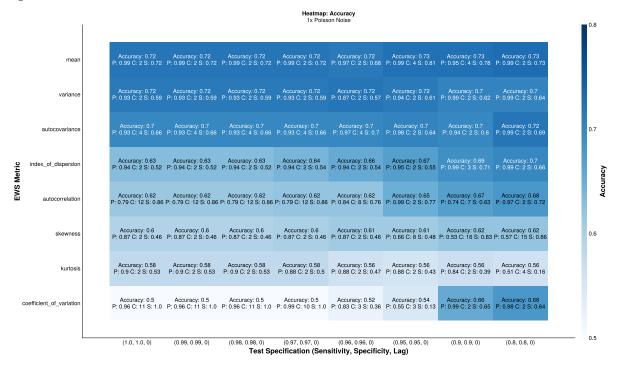


Figure 9: The maximal alert accuracy under 1x Poisson noise. P) refers to the long-running percentile threshold to return a flag, and C) the number of consecutive flags to trigger and alert, that in combination produce the maximal accuracy. S) refers to the specificity of the alert system

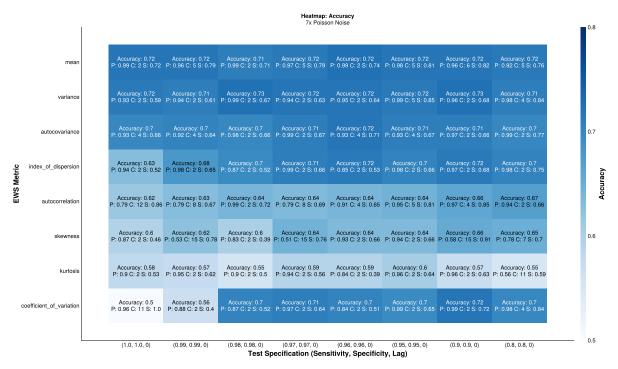


Figure 10: The maximal alert accuracy under 7x Poisson noise. P) refers to the long-running percentile threshold to return a flag, and C) the number of consecutive flags to trigger and alert, that in combination produce the maximal accuracy. S) refers to the specificity of the alert system



Figure 11: The maximal alert accuracy under 1x Dynamical noise. P) refers to the long-running percentile threshold to return a flag, and C) the number of consecutive flags to trigger and alert, that in combination produce the maximal accuracy. S) refers to the specificity of the alert system

		Heatmap: Accuracy 7x Dynamical Noise							0.8		
	mean		Accuracy: 0.72 P: 0.99 C: 2 S: 0.72	Accuracy: 0.7 P: 0.85 C: 2 S: 0.75	Accuracy: 0.7 P: 0.84 C: 2 S: 0.88	Accuracy: 0.68 P: 0.8 C: 2 S: 0.87	Accuracy: 0.66 P: 0.73 C: 2 S: 0.64	Accuracy: 0.66 P: 0.72 C: 2 S: 0.62	Accuracy: 0.6 P: 0.73 C: 2 S: 0.69	Accuracy: 0.54 P: 0.64 C: 10 S: 0.85	
EWS Metric	variance		Accuracy: 0.72 P: 0.93 C: 2 S: 0.59	Accuracy: 0.64 P: 0.65 C: 5 S: 0.68	Accuracy: 0.61 P: 0.65 C: 4 S: 0.96	Accuracy: 0.58 P: 0.53 C: 2 S: 0.81	Accuracy: 0.56 P: 0.51 C: 3 S: 0.81	Accuracy: 0.54 P: 0.59 C: 3 S: 0.92	Accuracy: 0.52 P: 0.61 C: 2 S: 0.93	Accuracy: 0.52 P: 0.56 C: 9 S: 0.96	
	autocovariance		Accuracy: 0.7 P: 0.93 C: 4 S: 0.66	Accuracy: 0.64 P: 0.69 C: 2 S: 0.6	Accuracy: 0.6 P: 0.64 C: 4 S: 0.96	Accuracy: 0.58 P: 0.51 C: 5 S: 0.88	Accuracy: 0.55 P: 0.5 C: 5 S: 0.87	Accuracy: 0.54 P: 0.5 C: 4 S: 0.82	Accuracy: 0.52 P: 0.54 C: 9 S: 0.96	Accuracy: 0.52 P: 0.56 C: 4 S: 0.9	0.7
	index_of_dispersion		Accuracy: 0.63 P: 0.94 C: 2 S: 0.52	Accuracy: 0.54 P: 0.52 C: 12 S: 0.73	Accuracy: 0.54 P: 0.56 C: 7 S: 0.9	Accuracy: 0.52 P: 0.5 C: 5 S: 0.88	Accuracy: 0.52 P: 0.51 C: 2 S: 0.82	Accuracy: 0.51 P: 0.5 C: 4 S: 0.91	Accuracy: 0.51 P: 0.64 C: 3 S: 0.92	Accuracy: 0.52 P: 0.59 C: 2 S: 0.85	Acciliany
	autocorrelation		Accuracy: 0.62 P: 0.79 C: 12 S: 0.86	Accuracy: 0.54 P: 0.78 C: 8 S: 0.95	Accuracy: 0.53 P: 0.64 C: 17 S: 0.99	Accuracy: 0.55 P: 0.6 C: 8 S: 0.82	Accuracy: 0.53 P: 0.53 C: 13 S: 0.87	Accuracy: 0.52 P: 0.6 C: 13 S: 0.94	Accuracy: 0.54 P: 0.6 C: 13 S: 0.91	Accuracy: 0.54 P: 0.58 C: 10 S: 0.65	A
	skewness		Accuracy: 0.6 P: 0.87 C: 2 S: 0.46	Accuracy: 0.59 P: 0.51 C: 11 S: 0.78	Accuracy: 0.6 P: 0.51 C: 11 S: 0.74	Accuracy: 0.59 P: 0.55 C: 11 S: 0.95	Accuracy: 0.58 P: 0.51 C: 11 S: 0.96	Accuracy: 0.57 P: 0.53 C: 10 S: 0.9	Accuracy: 0.57 P: 0.57 C: 9 S: 0.82	Accuracy: 0.54 P: 0.52 C: 10 S: 0.76	0.6
	kurtosis		Accuracy: 0.58 P: 0.9 C: 2 S: 0.53	Accuracy: 0.54 P: 0.55 C: 4 S: 0.26	Accuracy: 0.55 P: 0.84 C: 2 S: 0.87	Accuracy: 0.55 P: 0.73 C: 2 S: 0.63	Accuracy: 0.57 P: 0.7 C: 3 S: 0.81	Accuracy: 0.54 P: 0.5 C: 4 S: 0.51	Accuracy: 0.55 P: 0.68 C: 2 S: 0.68	Accuracy: 0.52 P: 0.67 C: 2 S: 0.68	
c	oefficient_of_variation		Accuracy: 0.5 P: 0.96 C: 11 S: 1.0	Accuracy: 0.51 P: 0.89 C: 9 S: 0.98	Accuracy: 0.51 P: 0.5 C: 8 S: 0.69	Accuracy: 0.52 P: 0.5 C: 8 S: 0.85	Accuracy: 0.52 P: 0.63 C: 6 S: 0.89	Accuracy: 0.53 P: 0.52 C: 2 S: 0.59	Accuracy: 0.52 P: 0.63 C: 7 S: 0.89	Accuracy: 0.52 P: 0.61 C: 7 S: 0.89	
			(1.0, 1.0, 0)	(0.99, 0.99, 0)	(0.98, 0.98, 0) Test Sp	(0.97, 0.97, 0) pecification (Sen	(0.96, 0.96, 0) sitivity, Specific	(0.95, 0.95, 0) ity, Lag)	(0.9, 0.9, 0)	(0.8, 0.8, 0)	0.5

Figure 12: The maximal alert accuracy under 7x Dynamical noise. P) refers to the long-running percentile threshold to return a flag, and C) the number of consecutive flags to trigger and alert, that in combination produce the maximal accuracy. S) refers to the specificity of the alert system

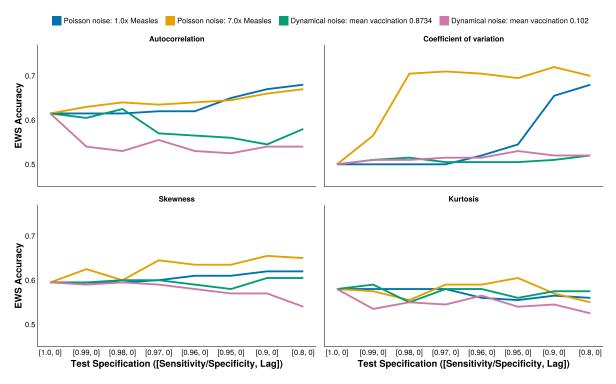


Figure 13: The change in alert accuracy for less correlated EWS metrics under increasing diagnostic uncertainty, and low and high levels of Poisson or dynamical noise

Survival Analysis

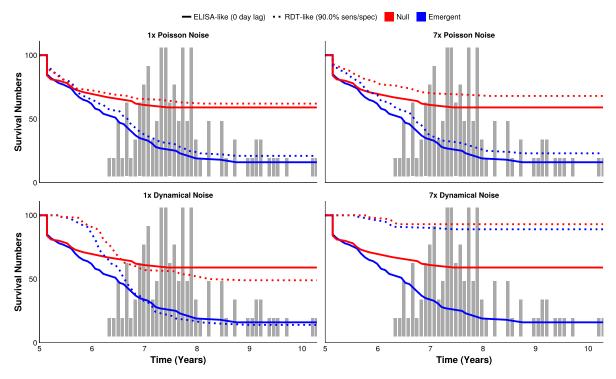


Figure 14: Survival curves for the variance EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_E=1$) under the emergent simulation, right-truncating the curves

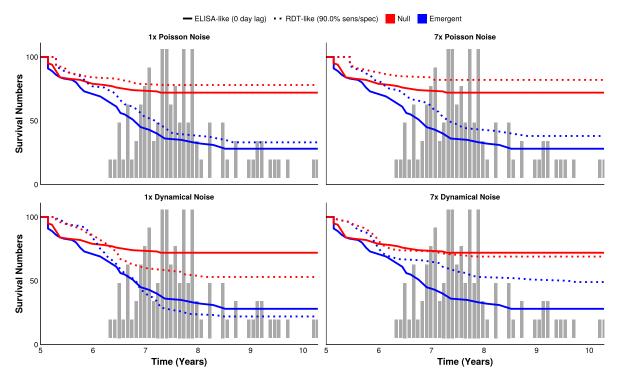


Figure 15: Survival curves for the mean EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_{\rm E}=1$) under the emergent simulation, right-truncating the curves.

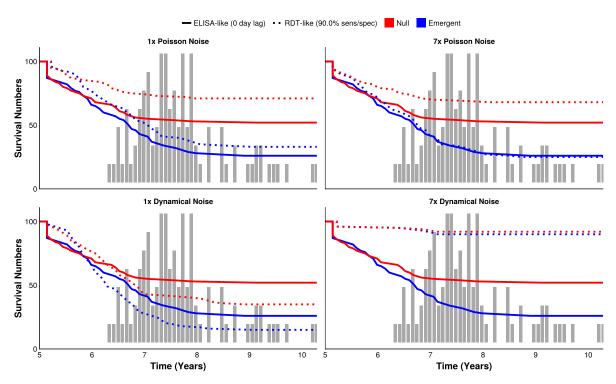


Figure 16: Survival curves for the index of dispersion EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_E=1$) under the emergent simulation, right-truncating the curves.

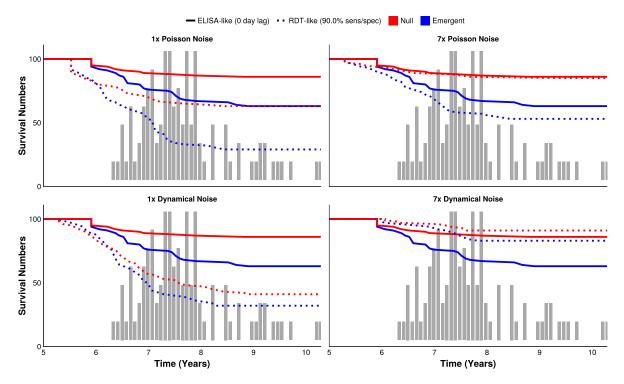


Figure 17: Survival curves for the autocorrelation EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_{\rm E}=1$) under the emergent simulation, right-truncating the curves.

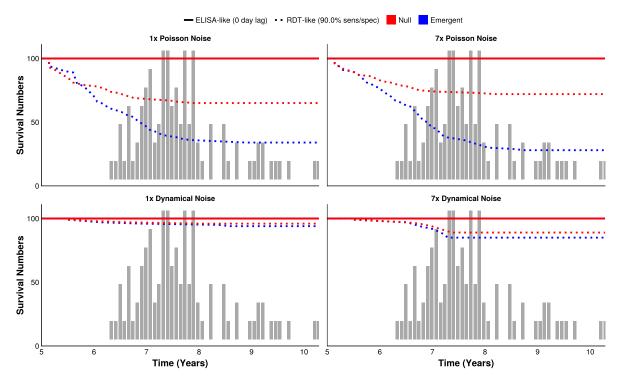


Figure 18: Survival curves for the coefficient of variation EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_E=1$) under the emergent simulation, right-truncating the curves.

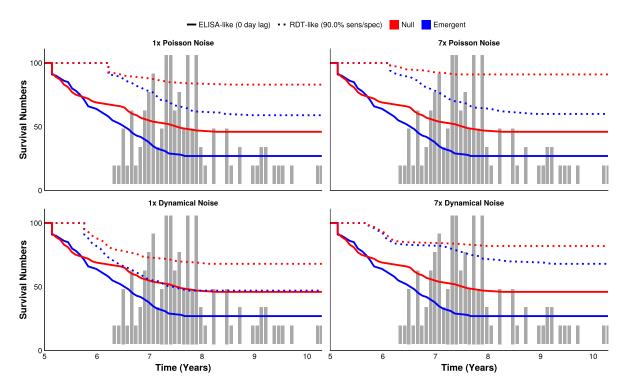


Figure 19: Survival curves for the skewness EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_E=1$) under the emergent simulation, right-truncating the curves.

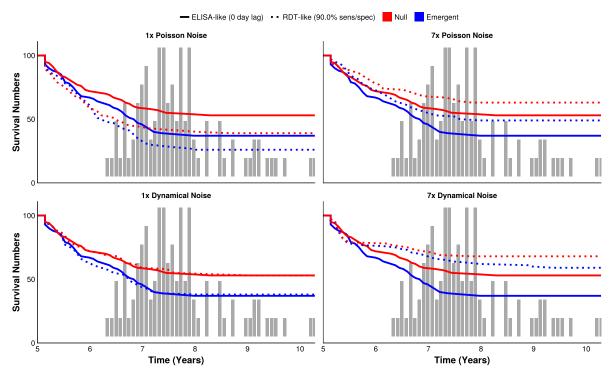


Figure 20: Survival curves for the kurtosis EWS metric computed on emergent and null simulations, with a perfect test and an RDT equivalent with 90% sensitivity and specificity. The histogram depicts the times when the tipping point is reached ($R_E=1$) under the emergent simulation, right-truncating the curves.