Session No.

# Use of the extreme value theory to select and study cardiovascular peaks


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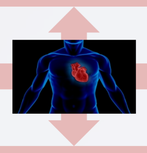
## 1.Background

Studies focus on **mean events**

Cardiovascular disease: **heart** and **blood vessel**



In QC, 1st cause of **deaths** and 2nd of **hospitalisations**

**Peaks** ≠ mean events

- **Health peaks**: extreme values of the sanitary variable
- Less probable and away from the mean values
- Management issues for health network because of their difficulty to predict
- Health peaks require appropriate **statistical treatment**

## 2.Objectives

Main objective: **health system support**

- **Selection** of health peaks with appropriate statistical tools
- **Modeling** and study of health peaks
- Development of an objective methodology

## 3.Methods

**Extreme value theory (EVT)**

- How to define peaks?

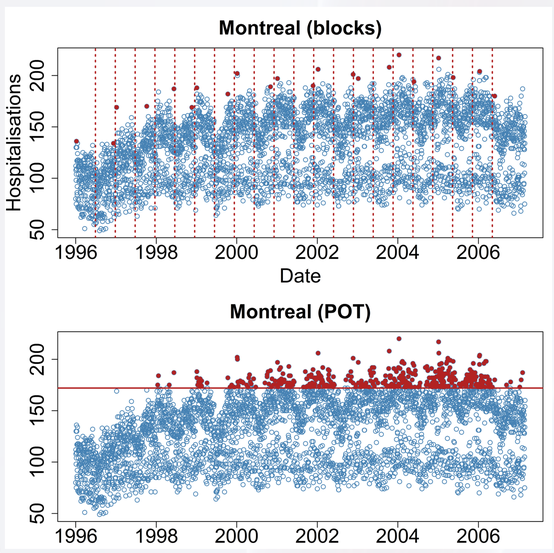
→ **Blocks**, peaks fitted by the generalized extreme value distribution (GEV)

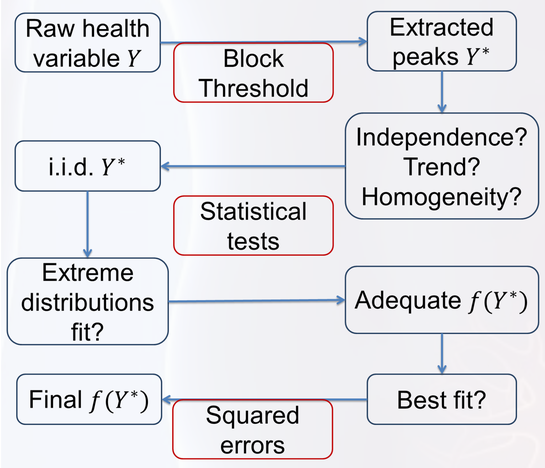
→ **Peak-over-threshold** (POT), peaks fitted by the generalized Pareto distribution (GPD)

- Different **hypotheses** are tested on extracted peaks
  - → No trend (Mann-Kendall MK)
  - → Independence (Wald-Wolfowitz WW)
  - → Homogeneity (Wilcoxon WX)

- Peaks adequacy to different **extreme distributions** is tested
  - → Kolmogorov-Smirnoff (KS)
  - → Anderson-Darling (AD)

- Best fit → **return level**: mean expected level to be reached or exceeded over a certain period

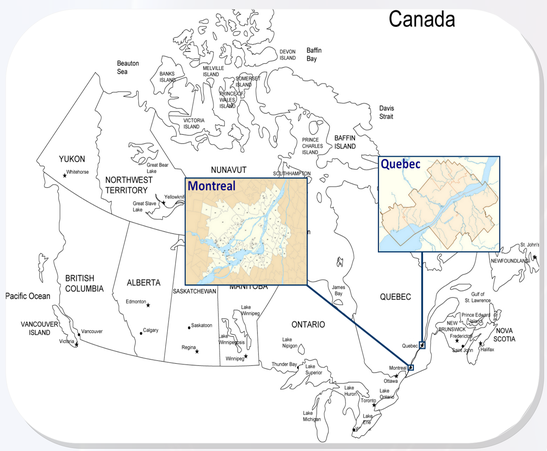



## 4.Data

- Daily CVD hospitalisations
  1996 to 2006 → n = 4077
- Daily CVD deaths
  1981 to 2011 → n = 11322

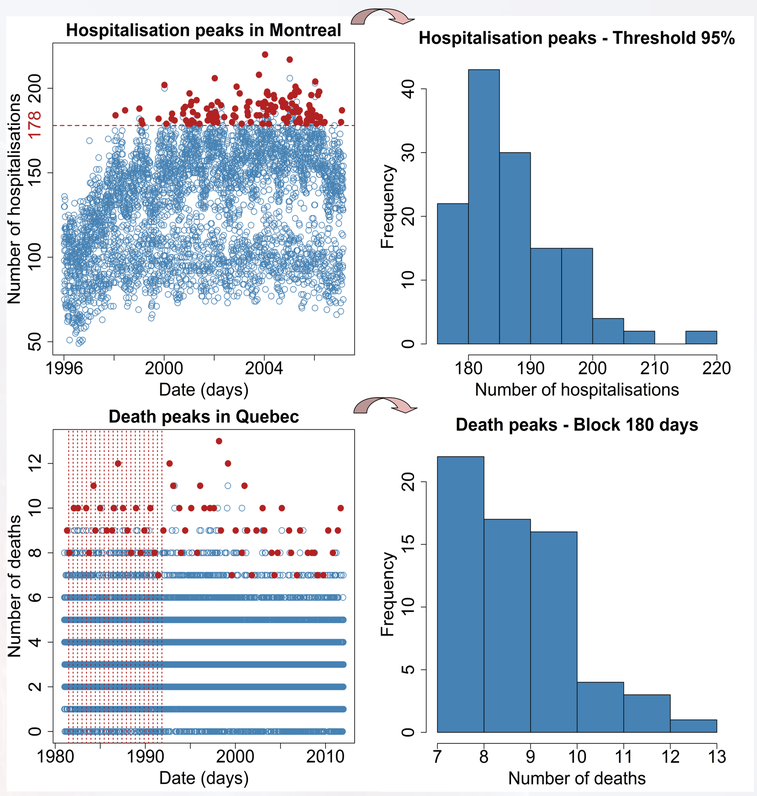
| | Hospitalisations in Montreal | Deaths in Quebec |
|---|---|---|
| **Minimum** | 49 | 0 |
| **Maximum** | 220 | 13 |
| **Mean** | 131 | 3 |




## 5.Results

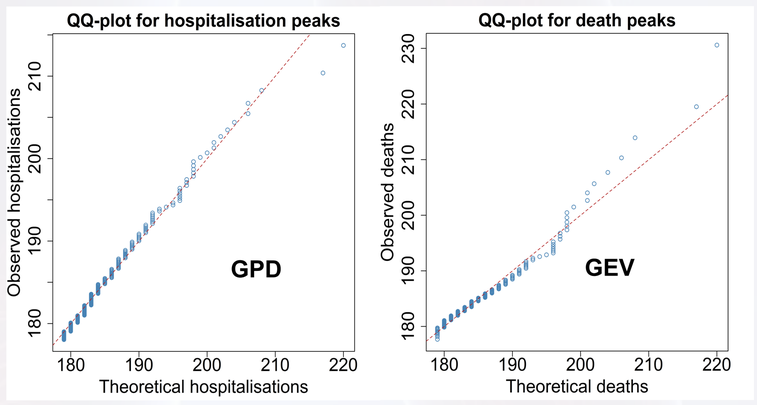
**Selected results**

- Hospitalisations in Montreal: POT method (threshold 95 %)
- Deaths in Quebec: blocks method (block size 180 days)



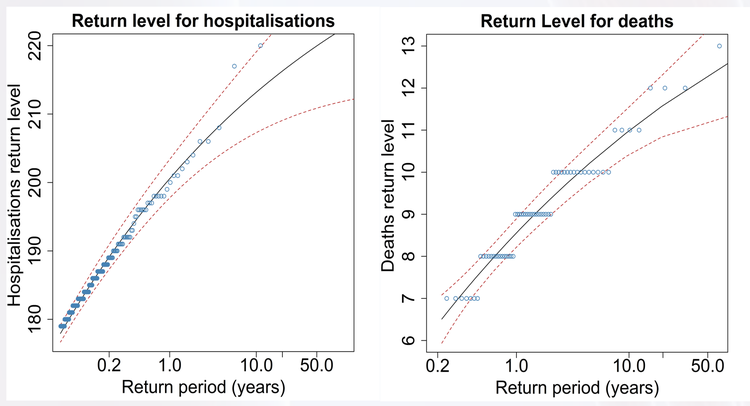

**Modeling results**

| | Montreal GPD | | | | | | |
|---|---|---|---|---|---|---|---|
| | EVT hypotheses (p-value) | | | Estimated parameters | | Adequacy (p-value) | |
| n | MK | WW | WX | $\hat{\xi}$ | $\hat{\sigma}$ | KS | AD |
| 133 | 0.13 | 0.17 | 0.24 | -0.37 | 13.14 | 0.45 | 0.35 |
| | **Quebec GEV** | | | | | | |
| n | MK | WW | WX | $\hat{\xi}$ | $\hat{\mu}$ | $\hat{\sigma}$ | KS | AD |
| 63 | 0.01 | 0.07 | 0.64 | -0.14 | 8.57 | 1.23 | 0.12 | 0.13 |




**Return levels**

- Montreal: **198 hospitalisations** are expected to be reached or exceeded over **1 year**, 212 hospitalisations over 10 years (mean level: 131)
- Quebec: **8 deaths** are expected to be reached or exceeded over **1 year**, 11 deaths over 10 years (mean level: 3)




## 6.Conclusions

- Return levels are interesting for health institutes management by providing useful information during **peak periods**
- Methodology can be of interest when searching for **external factors** (meteorological conditions, social stress, pollution, etc.)
- Main limitation: **small samples**
- Methodology applicable to other regions or health variables

## References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- AghaKouchak, A., Easterling, D., Hsu, K., Schubert, S., & Sorooshian, S. (Eds.). (2012). *Extremes in a changing climate: detection, analysis and uncertainty* (Vol. 65). Springer Science & Business Media.



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