Phase – out of phase – lagged

Patterns:

* All regions had Rt estimates (therefore the relationships between Rt estimates) as waves – not smooth linear relationship; but synchrony, frequency/amplitude, presence / direction of trend varied by region and over time
* Consistent features: cases higher average Rt estimate and higher frequency + amplitude of variation than admissions or deaths; admissions or deaths similar

Groupings:

* South west and north west?
* London
* Midlands, South East?
* NEY
* East

England

* Rt and case overall
  + Counts from community declined more rapidly from (March) peak than admissions or deaths, then matched admissions over June through to July
  + Late June/early July divergence with increasing case counts from community and continuing downward trend from admissions/deaths
  + Rt estimates moved in sine waves, but frequency and amplitude varied by data source
* Cases
  + Stable (mean 0.8, CI) April through mid June
  + Two waves, peak in late June at 1.4, again in late July at 1.2
    - Short wavelength – from 0.8 to 1.4 over 1 week
    - Drop to higher level than previous, 0.95
    - Smaller wave to 1.15 late July (early Aug), decline to 0.99
* Admissions
  + Low amplitude waves with monthly period (peaks in late April, mid May, mid June), around a centre of 0.9, amplitude +- 0.01
  + Fell to trough at 0.8 in early July, then again to previous level before a roughly linear increasing trend through July and August, meeting the Rt from cases by late August at 0.95
* Deaths
  + Three waves over April-August, no clear linear trend
    - Roughly 4-5 week period?
    - Peaks in early May, early June, late July

North West

* Rt and case overall
  + within CIs with cases consistently higher than admissions or deaths by July by time admissions and deaths had fallen to trough. Similar pattern in sharp rise (1wk?) early July and similar fall later July, all synchronous.
* Admissions and deaths
  + 0.8 and 1 in May; fall to trough (0.75, 0.8) in July, much sharper for admissions than any other; July rise sharply (0.75-1.15 in admissions over 2 weeks)
  + Admission & deaths track each other (ratio range 0.9-1.2)
  + Ratio is sine with increasing amplitude, ? monthly periodicity
  + Because admissions more variable than deaths early on (0.1 range through May-June)
  + Fall with deaths slightly lagged to 0.9
* Cases
  + Within CI of admissions and deaths through May, June; low of 0.85 in late May
  + Sharp rise at same time as admissions and deaths in late June, early July: 0.9 to peak 1.2 in 2nd week of July
  + Fall as with admissions and deaths through July and August, all falling to 0.9

North East

* Rt and case overall
* Cases
  + After first wave, fall to 0.85, but sharp (2 week) spike in June. (Check against testing rates.) After falling back to Rt in May (0.85), another equally rapid increase to 1.05, with a small inter-peak fall (??) and rise to peak at 1.15 by August. Then declined to 1
* Admissions
  + April – minor wave, 0.85-0.9
  + May – 0.85, rising
  + June – 0.9, falling
  + July – 0.8; rise (1wk) to 1, similar (more stable than) cases
  + Aug –0.85, falling, as with cases
* Deaths
  + April, May – 0.85-0.9, near identical to admissions
  + May – steady fall, 0.8
  + June – 0.8, steady
  + July, Aug – rise, to 0.95 by August, no decline as in case/admissions

Midlands

* Rt and case overall
* Cases
  + April – fall to 0.95
  + May – August: High frequency waves (period<1month), varying amplitude (+- 0.01 in May and July, vs +- 0.1 in June)
  + Trend increasing (take MA – from 0.9 in May to 1.1 in early August)
  + Not similar to admissions or deaths
* Admissions & deaths
  + Admissions and deaths similar (synchronous) until late July
  + May-June deaths lower than admissions (ratio 10% higher for admissions)
  + Fall over June to match at 0.75; start identical rise to 0.9 by mid July
  + Deaths then fall back to 0.75 by late August
  + Admissions rise to 1.15 by late Aug, narrowing ratio with cases (from cases at 20% higher to admissions at 10% higher)

London

* Rt and case overall
  + Peaked earlier than other regions – not shown on limited x axis
  + Unlike other regions, all show increasing trend on average from May through August
* Cases
  + Smoother, lower frequency and amplitude waves than any other region
  + Relationship with deaths – centred 20% higher, waves ~1month, amplitude 10%, no clear direction of trend
* Deaths & Admissions
  + Admissions
    - Low frequency waves: 1-2 month period
    - 0.75-0.85-0.75 over April-May
    - May - Steep rise (1wk) to 0.98 early June
    - Held through June where matched deaths
  + Deaths
    - High frequency waves (period 2 week?), varying amplitude (eg max +2, June-Jul – amplitude = distance from centre of wave (ie mean\_))
  + Deaths and admissions near identical pattern and level over late June through August
  + Steady till fall over July to trough 0.8
  + Rise to 1 over July-Aug

South West

* Rt and case overall
  + All Rt meet at 0.7 in June
* Cases
  + Fall from 1.01 to 0.8 through April, May; small rise to match deaths over May
  + Near identical with deaths over May-June
  + After trough (0.7), steep (2wk) rise to peak at 1.2 in July
  + July-Aug – another wave with much lower amplitude
* Admissions & deaths
  + Similar patterns, different level – admissions higher than deaths over May through July; then match to identical July-August
  + Pattern: rise from 0.8 to (0.85, 0.95) in May; fall (2wk) to June; both rise from trough (0.7) through August to 1.1
  + Admissions rise more steeply but with minor wave late June; deaths consistent smooth rise; identical from late June

East

* Rt and case overall
  + Only region where deaths had stronger amplitude waves, and peaked higher than cases (mid June, ratio 20% higher than cases)
* Cases
  + Fell over April May to 0.85; lower than admissions
  + Relationship with admissions – similar pattern in fall over April-May, small wave over early June, fall by July, steeper rise late June-early July; steeper for cases than admissions
  + Relationship with deaths – slight increase in trend over time, waves with centre 1.2, amplitude 0.5
* Admissions
  + Low-amplitude (0.1) waves, 1 month length
  + Slight decreasing trend over time? 0.9 to 0.85
  + Relationship with deaths – no clear trend over time series, centred on admissions 10% higher than deaths, wavelength 1 month
* Deaths
  + Two very minor waves
  + One strong high-amplitude wave, peak at 1.01 in mid June, trough to 0.7 either side late May and early July, increase following over Jul-Aug
  + Similar but lower amplitude wave and lagged by 1 month in cases and admissions

South East

* Rt and case overall
  + SE and Midlands had smoother relationships between Rt from different data sources than other regions
  + Stronger trend to higher Rt from cases compared to deaths or admissions, and admissions to deaths
* Cases
  + Within confint of admissions/deaths over May to July, although flat through first peak in latter
  + Small wave over July, trend to increasing Rt from June to latest (1.2)
* Admissions/deaths
  + Near identical until late July
  + Two waves with peak in mid May and late June
  + Diverge in late July where admissions do not fall from peak of wave but remain stable; deaths continue to fall to series minima at 0.6

**Use Rt to look for differences in patterns (waves)**

**Use ratios (+- %) to look for differences in level**