Day Interpretation

1 Primary Aim

The primary aim of day interpretation is to create pseudo days in which all the peak flow readings are either all exposed or all non-exposed. Additionally each pseudo day must contain exactly one waking reading.

The key concept is that a patient can feel the effects of exposure after being exposed but cannot possibly feel the effects before exposure. Hence a waking reading for a work pseudo day needs to be after the exposure, i.e. from the following day.

2 Secondary Aims

This method of day interpretation was produced after discussion with experts and tries to agree with an expert interpretation. The rules are complex and not easily readable. Hence the application of the rules in various situations is described below.

2.1 Night shifts

When a patient goes on to a night shift from resting there is often a large time imbetween them waking up and going to work. The rules will make a rest pseudo day out of this time if it is long enough (which is common). Sequence 1 describes this behaviour.

When a patient goes on to a night shift from a day shift there is often a large time imbetween the end of exposure from the day shift and the start of exposure on the night shift. The rules will make a rest pseudo day out of this time if it is long enough (which is common). Sequence 5 describes this behaviour.

When a patient comes off a night shift there is usually a short period awake on that day, some of which may still be affected from the night shift exposure. The rules make a rest pseudo day from the time when it is likely that readings are unaffected by exposure until the patient returns to bed, but only if this time is long enough (which is reasonably common).

2.2 Working

When a patient is working a constant shift for a number of days all readings are normally said to be exposed. The rules usually create work pseudo days from one time of starting work to the next. Sequence 4 describes this behaviour.

2.3 Resting

When a patient is resting for a number of days all readings are said to be non-exposed. The rules create rest pseudo days from after a waking reading through to after the next waking reading. Sequence 2 describes this behaviour.

2.4 First day readings

The exposure on the day before the first day of a peak flow record is not known. It is possible that an exposure on this day will have an affect on the peak flow readings on the first day. The interpretation assumes that all readings after the waking reading are not affected by the previous day. In practice this is usually a good assumption for the following reasons:

- If the first day of the peak flow record is a work day then the readings are exposed anyway so exposure from the previous day is less relevant.
- The first day of a peak flow record is generally a Monday, which is a workday and usually precedes a Sunday off work (so no exposure on the previous day)
- If the previous day is a day shift then the effects of exposure are likely to be minimal.
- If the previous day is a night shift then this will encroach onto the first day and hence will be known.

An afternoon shift on the previous day and a day off on the first day of the record is the most likely to cause a problem, but this is a rare sequence of events. In order to avoid this issue the exposure for the previous day can be entered.

2.5 Waking readings

A waking reading is the first reading taken after waking, up to a maximum of 90 minutes.

A rest waking reading is a waking reading taken away from work after a rest day. A work waking reading is anything else.

Where there is no waking reading for a day one will be created by copying the value of the nearest waking reading of the same type (working or resting).

Sometimes waking readings will have been taken at work. For example when a patient wakes up at 7.00am, starts work at 7.30am and takes a reading at 8.00am. These waking readings will be removed if they follow a rest day as rest pseudo days require a non exposed waking reading. When this happens a new waking reading will be created.

2.6 Event markers and non consecutive pseudo days

There are often periods of time that are not included in any pseudo day, for a number of reasons. It is desirable to retain the event markers during these periods. Oasys currently calculates the average by time from waking (for which the wake events markers are required) and the time spent sleeping and working each day (for which all the markers are required. It is likely that further uses for the event markers will be found as the program is developed. For these reasons no event markers will be left out of the interpretation even if they fall during a period of time that is not included in any pseudo day.

3 Manual modification of the interpretation

The interpretation is not modifiable after it has been created. This is because the expertise used in defining the interpretation will be greater than that of the average user. If there are missing or incorrect events then the interpretation may produce undesirable results. In these cases the events can be edited by the user and the interpretation re run to produce a quality interpretation.

4 Pseudo Days

The interpretation process defines a concept of pseudo days, which are the equivalent of 24 hour days. A pseudo day must contain exactly one waking reading and may contain one or more spells at work, in which case the pseudo day must start with the first work spell. There are only three types of pseudo days, rest, work and the special blank type. It is allowable for a pseudo day to contain no peak flow readings. These will be called empty pseudo days, but note that they will still be either working, resting or the special blank type.

5 Waking readings

A waking reading is defined as the first reading up to and including 90 minutes after a waking event, regardless of any other events in that 90 minute period. For example if there is a reading 80 minutes after a waking event but also 10 minutes after a starting work event then that reading is still the waking reading, even though it was taken at work.

A waking reading is said to be exposed or non-exposed. If the previous time that the patient was awake included a spell at work then the waking reading is said to be exposed; otherwise it is said to be non-exposed. If it is not known what the patient was doing on the previous time awake then the exposure is said to be unknown.

6 The Rules

6.1 Notation

The following notation is used to describe the rules.

R – Start of data
W – Wake event
S – Start work event
E – End work event
B – Go to bed event
D – Discontinuity (Indicating it is not known whether the patient was working at this point)
(…) One or more repetitions of the events in the brackets
[…] Zero or more repetitions of the events in brackets
{…} Any one of the sequences (separated by commas) within the brackets is allowed

6.2 Event order

If the order of the events does not adhere to the following pattern then no interpretation should be performed.

R(W{[SE],D}B)

6.3 Explanation

The interpretation should keep a textual description of how the interpretation was made. People can read this and make decisions in cases where the interpretation is not as they expected. The following require explanation, unless specified otherwise by the sequence they apply to:

- Complex break up. In a W(SE)BWBWS sequence of events it is possible for no rest pseudo day to be created. In this case it should be emphasised that this results in one less complex than might be expected. Sequences 1 and 6 describe the behaviour for this.
- Unusually short (6½ hours or less) pseudo days.
- Unusually long (29½ hours or more) pseudo days.
- Additionally the sequences state circumstances that require explanation.

6.4 Creating events

A waking event should be created 8 hours after the final go to bed event and a go to bed event should be created 8 hours after that. This allows the sequences for creating pseudo days to be simpler as no special sequences are required to account for the end of the data.

6.5 Deleting waking readings

If the exposure for a waking reading is said to be unknown then it should be deleted. This happens on the first day and after blank days, as there is no information as to what the patient was doing previously.

If a waking reading that is said to be non-exposed is taken at work then it should be deleted.

It is possible that there are two or more readings with 90 minutes of a waking event. When deleting the waking reading in these cases the first reading should be deleted and subsequent readings should remain but should not be used as waking readings.

6.6 Creating waking readings

If possible waking readings should be created for all waking events that do not have corresponding waking readings (even waking events for which waking readings have been deleted). A waking reading is created by copying the waking reading for the nearest waking event that is said to be of the same exposure. The nearest is calculated on the time difference between waking events (not the time of the waking reading, which will be after the waking event). If there is a tie then the one in the future is used. If there are no existing waking readings that are said to be of the same exposure then no waking reading is created. No attempt should be made to create waking readings where the exposure is said to be unknown.

6.7 Including event markers

Initially pseudo days are created as described below and have a specified start / end date and time. All readings between these times are included with the relevant pseudo days. The pseudo days are then sorted and the event markers are added. The first pseudo day includes event makers from the start of the events to it's end date and time. The second to penultimate pseudo days include all event markers

from the end date and time of the previous pseudo day to their end date time. The last pseudo day includes all event markers from the end date and time of the penultimate pseudo day to the last of the events.

6.8 Creating pseudo days

For every unique set of one of the following sequences a pseudo day is created between the start and end times, subject to the conditions. All readings between these times are copied to the pseudo day. Events are discussed later.

Onwards and Until are used to indicate exclusivity for the start and end times. If they are not specified then readings on the time specified are inclusive. For example 'Onwards of the waking reading' means start at the time of the waking reading but do not include it.

The pseudo days are sorted by the start times. To ensure that all events remain in the pseudo days (which is convenient for analysis and display) events are copied from the end of one pseudo day to the end of the next one. The first pseudo day includes all events from the start of the record. The last pseudo day includes all events at the end of the record.

The sequences define what type of pseudo day is to be created.

6.8.1 Sequence 1: WBWS (Rest pseudo day)

Description –A rest day followed by a work day. A rest pseudo day is created from the portion of the work day before starting work if it is long enough (as would generally be the case with a night shift).

Start Time - The start time is the second W.

End Time - The end time is until the S.

Conditions:

- Must be a waking reading for the second W.
- If the waking reading was created for the second W then there must be at least one other reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty rest pseudo day.
- Pseudo day must be 7½ hours long or more.

Explanation:

- If there is no waking reading for the second W then the explanation should state that the pseudo day was excluded for this reason.
- If the pseudo day is 6½ or more hours long and less than 7½ hours long then the explanation should state that the pseudo day was a marginal case for inclusion but was left out.
- If the pseudo day is 7½ or more hours long and less than 8½ hours long then the explanation should state that the pseudo day was a marginal case for exclusion but was kept.

6.8.2 Sequence 2: WBWBW (Rest pseudo day)

Description – A rest day preceded by another rest day. A rest psuedo day is created from the second rest day.

Start Time - The start time is (onwards of the waking reading for the second W) or (onwards of the second W), whichever is later.

End Time - The end time is the waking reading for the third W.

Conditions:

- Must be a waking reading for the third W.
- If the waking reading was created for the third W then there must be at least one other reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty rest pseudo day.

Explanation:

- If there is no waking reading for the third W then the explanation should state that the pseudo day was excluded for this reason.

6.8.3 Sequence 3: {R,DB}WBW (Rest pseudo day)

Description – A rest day preceded by a day where the exposure is unkown. A rest pseudo day is created from thie rest day assuming that all readings apart from the waking reading are unexposed.

Start Time - The start time is (onwards of the waking reading for the first W) or (onwards of the first W) whichever is later.

End Time - The end time is the waking reading for the second W.

Conditions:

- Must be a waking reading for the second W.
- If the waking reading was created for the second W then there must be at least one other reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty rest pseudo day.

Explanation:

- If there is no waking reading for the second W then the explanation should state that the pseudo day was excluded for this reason.

6.8.4 Sequence 4: W(SE)BWS (Work pseudo day)

Description – A work day followed by another work day. A work pseudo day is created from the first work day.

Start Time – The start time is (the first S) or (onwards of the waking reading for the first W) whichever is later.

End Time – The end time is ((until the last S) or (until the time of the first S on the first possible day whereby the end time is after the last E) whichever is earlier) or (the waking reading for the last W) whichever is later.

Conditions:

- Must be a waking reading for the last W.
- If the waking reading was created for the last W then there must be at least one other reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty work pseudo day.

Explanation

- If no waking could be created then the explanation should state that the pseudo day was excluded for this reason.

6.8.5 Sequence 5: W(SE)BWS (Rest pseudo day)

Description – A work day followed by another work day. If there is a long time awake between the expected end of exposure from the first work day and the start of exposure on the second work day then a pseudo rest day is created. This is reasonably common when moving from day shifts to night shifts.

Start Time – The start time is ((the last S) or (the time of the first S on the first possible day whereby the end time is after the last E) whichever is earlier) or ((onwards of the waking reading for the last W) or (onwards of the last W) whichever is later) whichever is later.

End Time – The end time is until the last S.

Conditions:

- A waking reading that is said to be non-exposed must be created for the last W and must be included in the pseudo day, regardless of the time of waking and the start time of the pseudo day. The procedure for creating a waking reading that is said to be on exposed is described in section *6.6 Creating Waking Readings*. If a waking reading can't be created then don't create the pseudo day.
- There must be at least one reading other then the created waking reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty rest pseudo day.
- Pseudo day must be 9½ hours long or more.

Explanation:

- If no waking could be created then the explanation should state that the pseudo day was excluded for this reason.
- If the pseudo day is 9½ hours long or more then the explanation should emphasise that the inclusion of the pseudo day has resulted in a new complex.

- If the pseudo day is 4½ or more hours long and less than 9½ hours long then the explanation should state that this pseudo day was a marginal case for inclusion but was left out. It should also be emphasised that if left in the pseudo day would create a new complex.
- If the pseudo day is 9½ or more hours long and less than 10½ hours long then the explanation should state that this pseudo day was a marginal case for exclusion but was kept.

6.8.6 Sequence 6: {R,DB}WS (Rest pseudo day)

Description – A work day preceded by a day when the exposure is unknown. A rest pseudo day is created if there is a long time awake before starting work (as would generally be the case with a night shift).

Start Time - The start time is (onwards of the waking reading for the first W) or (onwards of the first W) whichever is later.

End Time – The end time is until the last S.

Conditions:

- A waking reading that is said to be non-exposed must be created for the last W and must be included in the pseudo day, regardless of the time of waking and the start time of the pseudo day. The procedure for creating a waking reading that is said to be on exposed is described in section *6.6 Creating Waking Readings*. If a waking reading can't be created then don't create the pseudo day.
- There must be at least one reading other then the created waking reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty rest pseudo day.
- Pseudo day must be 7½ hours long or more.

Explanation:

- If no waking could be created then the explanation should state that the pseudo day was excluded for this reason.
- If the pseudo day is 7½ hours long or more then the explanation should emphasise that the inclusion of the pseudo day has resulted in a new complex.
- If the pseudo day is 6½ or more hours long and less than 7½ hours long then the explanation should state that the pseudo day was a marginal case for inclusion but was left out and that if left in an extra complex would have resulted.
- If the pseudo day is 7½ or more hours long and less than 8½ hours long then the explanation should state that the pseudo day was a marginal case for exclusion but was kept.

6.8.7 Sequence 7: W(SE)BW{B,D} (Work pseudo day)

Description – A work day followed by a day when the exposure is unknown. A work pseudo day is created from the work day.

Start Time – The start time is (the first S) or (onwards of the waking reading for the first W) whichever is later.

End Time – The end time is (the waking reading for the last W) or (until the time of the first S on the first possible day whereby the end time is after the last E) whichever is later.

Conditions:

- Must be a waking reading for the last W.
- If the waking reading was created for the last W then there must be at least one other reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty work pseudo day.

Explanation

- If there is no waking reading for the last W then the explanation should state that the pseudo day was excluded for this reason.

6.8.8 Sequence 8: W(SE)BWBW (Rest pseudo day)

Description – A rest day preceded by a work day. A rest pseudo day is created from the rest day as long as there is enough time awake that is likely to be unexposed from the previous work day (this is not always the case when coming off night shifts).

Start Time – The start time is (onwards of the waking reading for the penultimate W) or (the time of the first S on the first possible day whereby the start time is after the last E) whichever is later.

End Time – The end time is the waking reading for the last W.

Conditions:

- Must be a waking reading for the last W.
- If the waking reading was created for the last W then there must be at least one other reading in the pseudo day. If this is not the case then don't include the created waking reading and hence create an empty work pseudo day.
- The time from the start time to the last B must be 3½ hours long or more.

Explanation:

- If there is no waking reading for the last W then the explanation should state that the pseudo day was excluded for this reason.
- If the time from the start time to the last B is 2½ or more hours long and less than 3½ hours long then the explanation should state that this pseudo day was a marginal case for inclusion but was left out.
- If the time from the start time to the last B is 3½ or more hours long and less than 4½ hours long then the explanation should state that this pseudo day was a marginal case for exclusion but was kept.

6.8.9 Sequence 9: WDBW (Blank pseudo day)

Description – A period of any length during which there is no exposure data. A blank pseudo day is made from the period.

Start Time – The start time is (onwards of the waking reading for the first W) or (onwards of the first W) whichever is later.

End Time – The end time is the last W.

Explanation:

- No explanation should be given if the period is unusually long.