

ROC QCPR Strategies

COMPRESSION RATE AND NO FLOW RATIO

Definitions

Compression Rate: The mean compression rate over the duration of a resuscitation, determined by the total number of recorded compressions divided by the duration of resuscitation time (in minutes) in which compressions could be recorded. This should include only time intervals in which the patient was without his or her own documented pulse. Time in which the presence or absence of compressions could not be determined should not be included in this time.

Alternative #1: First five minutes only

Alternative #2: Compression rate during chest compressions as a separate value

Alternative #3: Consider using impedance or pulse oximetry wave form as surrogates for the presence of a pulse.

No Flow Ratio: The time (in seconds) in which patient is without a pulse and does not receive chest compressions divided by the total time (in seconds) in which the patient is without a pulse. Time intervals in which the underlying rhythm and pulse state cannot be determined should be subtracted from both the numerator and the denominator.

Alternative #1: First five minutes only

Alternative #2: No flow ratio allowing for procedures and rhythm analysis as a separate value

Alternative #3: Consider using impedance or pulse oximetry wave form as surrogates for the presence of a pulse.

Acquisition

The following are acceptable methods to record chest compression rate:

- 1) Accelerometer (Philips/Laerdal and Zoll)
- 2) Impedance channel (Medtronic, Zoll without upgrade)
- 3) ECG in conjunction with audio recording (Medtronic, Zoll without upgrade)

Labor issues

- 1) *Determining pulseless from rhythm with pulses:* This will be an issue with all currently available technologies. All three devices (Philips/Laerdal, Zoll, Medtronic) include software allowing time stamps to mark time intervals for inclusion/exclusion in compression rate. This will require an individual review each resuscitation “by hand” using a combination of technologies. Each strategy will likely require 3 minutes of review for every minute of resuscitation. The availability of “more advanced” technologies will probably not save substantial time but will merely increase the accuracy or validity of recorded values. For early studies, a paramedic determination of pulse vs. pulselessness should be the gold standard. This may become problematic in a complex resuscitation without audio capability if the patient is in and out of an organized rhythm. The default (for compression rate and NFR calculations) should be to assume pulselessness if

- a pulse cannot be documented. Filtered ECG should be used whenever possible. If unavailable, then the assumption should be pulselessness during compressions.
- 2) *Determining chest compressions from background noise*: This is highly dependent on the available technology.

Accelerometer + ECG – This gives the most accurate documentation of chest compressions, which are relatively easy to define. The only exception may occur with “half-hearted” compressions, as with one-handed CPR with the other hand pushing the gurney. Since no standards exist to define a chest compression, any deflection recorded by the accelerometer should be counted for now. We can perform some pilot studies using compression depth in accelerometer-capable sites.

Impedance + ECG – The general approach is similar to the accelerometer + ECG approach, but there will likely be additional interference from ventilations. In addition, the filtered ECG will probably not be available. Again, the default should be to assume pulselessness during compressions for the purposes of compression rate and NFR. Training of the abstractor will become important for differentiating between ventilations and compressions. This will be less of an issue for determining compression rate as opposed to ventilation rate, since there will be many more compressions than ventilations.

Accelerometer/impedance + ECG + audio channel – Again, this will probably not save time but will allow more accurate determination of the presence of a pulse versus pulselessness. In addition, the audio channel will help define the timing of intubation and help differentiate ventilations from compressions for non-accelerometer sites.

ECG + audio channel – Most machines should have impedance available, which makes identifying chest compressions more reliable than ECG deflections alone. The strategy is no different from impedance + ECG, but the likelihood is that chest compressions will be identifiable only about 70% of the time.

VENTILATION RATE

Definitions

Ventilation Rate: The mean ventilation rate over the duration of a resuscitation, determined by the total number of delivered breaths divided by the duration of resuscitation time (in minutes) in which ventilations could be recorded. This should include only time intervals in which the patient was without his or her own breaths. Time in which the presence or absence of ventilations could not be determined should not be included in this time.

Alternative #1: First five minutes only

Alternative #2: Ventilation rates outside of the target range (6-16 breaths/min), which would require continuous or pseudo-continuous calculation of ventilation rate (may be possible only with capnometry).

Acquisition

The following are acceptable methods to record ventilation rate:

- 1) Capnometry
- 2) Audio recording with audible ventilation device (ie, whistle)
- 3) Impedance-determined value (automatically from devices)
- 4) Impedance channel inspection (manual)

Labor issues

There are issues with regard to both ease of collection and accuracy/data capture with ventilation rate, with technology playing a large role for both.

- 1) *Capnometry*: This carries the greatest advantage with regard to both ease of collection and accuracy/data capture. The manufacturers and our clinical experience suggest that even “dead” patients produce enough expired CO₂ to allow accurate ventilation rate. Although we have not specifically explored this issue, it is expected that near-continuous EtCO₂ and ventilation rate data will be available for analysis. The only critical review issue is in regard to intubated versus non-intubated patients. Using capnometry with BVM ventilation can assure continuous data collection, although about 5% of patients will have nondetectable EtCO₂ levels with BVM. This means, however, that some strategy for determining the moment of intubation will be required for intubation studies. In systems that only institute capnometry with intubation, we will not have any ventilation rate data prior to intubation (which may include the critical first shocks). Capnometry also offers the advantage of continuous tube confirmation.
- 2) *Audio recording*: This should have near-perfect accuracy, but it is untested and data capture may be an issue and may be agency (and individual) specific. The additional labor required over ECG/compression review is unclear – the Seattle group may be able to shed some light after their pilot. Ideally, the analysis software will allow for easy manual time stamping of ventilations with automatic ventilation rate computation. This will likely add another minute of review for every minute of resuscitation.
- 3) *Impedance-determined value*: This is the greatest unknown, since this technology is not yet validated. It is possible that the combination of the accelerometer and impedance channel (Philips/Laerdal and Zoll) with software to filter data can produce an accurate ventilation rate value with minimal effort. Whether the Medtronic impedance-only software can produce an accurate ventilation rate is unclear. At a minimum, manual review of the impedance waveform will be required as a quality assurance measure. The real question is whether this can serve as a sole measurement strategy. We have two options in this regard:
 - a. It may be reasonable to assume that this technology is appropriate as the sole strategy to measure ventilation rate for the purposes of study planning. It is likely that reliable measures will be available only one-half to two-thirds of the time, but this may be acceptable (especially since we had originally been discussing QCPR variables for only 5-10% of cases) as a starting point. This would give systems without additional technology or resistance to introducing additional changes all at once the option of starting slow and building from there. The expectation would be that over the next several years, new technology would be introduced to assure near-100% capture.

- b. The alternative approach is to state that the integration of QCPR variables into the analysis requires that we make a concerted effort to acquire data on as close to 100% of cases as possible. This would make the use of impedance-determine ventilation rate alone unacceptable. This carries a scientific advantage but will cost more and may meet resistance from agencies who are already being asked to make a lot of changes without obvious payback.
- 4) *Impedance channel inspection*: The issues are similar to those surrounding the use of impedance-determined values (see #3). A trained abstractor may be able to recognize ventilation waves from the impedance channel with a reliability approaching that of the machines; however, the accuracy and data capture remain undetermined. This is certainly more labor intensive than using a machine-derived value (as in #3) with some quality assurance inspection. Ultimately, we need to make a decision as to whether this is acceptable as a sole strategy for ventilation rate capture.