# Introduction to Use of the Modified Sequential Organ Failure Assessment (MSOFA)

## Origins and Purpose of MSOFA

The Modified Sequential Organ Failure Assessment (MSOFA) is an objective scoring system potentially useful in guiding critical care triage decisions in a crisis setting. Developed and validated for use in adults by Grissom et al.,[1] it provides a score that can be used to prioritize care for critically ill patients in a crisis setting, when many are sick or injured, and critical care resources are limited. Higher MSOFA scores suggest more severe illness and greater risk of death. Crisis care guidance from several states incorporates use of this tool. **N.B. MSOFA hasn't been validated for use in children age 18 years or younger**. [2]

Under the *Oregon Crisis Care Guidance*, MSOFA could be used in a crisis setting, when critical care resources are overwhelmed. It could serve as an additional tool to prioritize care, but would ***only*** be used when several patients are being evaluated simultaneously for admission to or continuation of critical care services, and when there are insufficient resources to provide critical care for all those being evaluated. Even in this setting, the MSOFA score is only one part of the broader pool of objective information considered by triage officers in making critical care allocation decisions. Experienced clinicians may triage multiple patients based on clinical status without utilizing MSOFA. For a more complete description of the Oregon Critical Care Triage model, see the Oregon Crisis Care Guidance, Appendix E www.theoma.org/CrisisCare .

## Purpose of this Document

Partners in the healthcare community have requested training materials to help them become familiar with use of MSOFA, so that they will be prepared to integrate it effectively into critical care triage activities in the event of a severe, sustained public health crisis. In response, the Oregon Crisis Care Guidance Critical Care Workgroup has developed this document for use in training of potential triage officers. The Workgroup hopes that, through use of these simple training materials, clinicians who might be involved in critical care resource allocation during public health crises can become familiar with use of MSOFA for assessment of patients, so that they will be prepared to use it, should the situation arise. The Workgroup welcomes feedback on ways the document can be made more useful. Please feel free to share any comments or suggestions by e-mail at crisiscare.comments@state.or.us .

MSOFA scoring chart is attached as Appendix 1.

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1. Grissom CK, Brown SM, Kuttler KG, et al. Disaster Med Public Health Preparedness 2010;4:277-284.
2. Sweney JS, Poss WB, Grissom CK, Keenan HT. Disaster Med Public Health Preparedness 2012:6:126-130.

## Necessary Information to Calculate an MSOFA Score

As you can see on the attached MSOFA Scoring matrix (Attachment 1), MSOFA involves assessment of respiratory, hepatic, circulatory, neurological, and renal status. To calculate an MSOFA score, you collect specific information regarding the level of function of these various organ systems. From this information, you calculate a sub-score for each of these organ systems. The sub-scores are then added together to determine the overall MSOFA score, which will be between zero and nineteen (0-19). Higher scores suggest more severe illness, and higher risk of mortality.

**To assess respiratory status:**

There are two options:

A) For patients <u>not</u> on a ventilator, use a pulse oximeter to measure percentage of hemoglobin saturation with oxygen ($SpO_2$) and determine the level of oxygen supplementation, in liters/minute, needed to maintain an $SpO_2$ of greater than 90%. You can then use this value to determine the respiratory sub-score, based on the MSOFA matrix.

Practice questions:

1) If a patient requires 8 liters/minute of supplemental oxygen to maintain an $SpO_2$ greater than 90%, what would the respiratory sub-score be?

2) If a person has an $SpO_2$ greater than 90% without supplemental oxygen, what respiratory sub-score would you assign?

B) For patients on mechanical ventilation, obtain the $SpO_2$ and the fraction of inspired oxygen "$FiO_2$", (e.g. ambient air is 0.21), then divide $SpO_2$ by the $FiO_2$ and calculate the respiratory sub-score (row 1) based on the values in the MSOFA Scoring Matrix[3]. For example, if a ventilated patient has an oxygen saturation of 94% on 40% FiO2, the SpO2/FiO2 ratio would be 94/0.4 = 235, yielding a row 1 sub-score of "2".

<u>Practice Questions</u>

3) If a ventilated patient has an $SpO_2$ of 82% on an $FiO_2$ of 0.95, what respiratory sub-score would you assign?

4) On the other hand, what would be the respiratory sub-score for a ventilated patient with an $SpO_2$ of 98% on an $FiO_2$ of 0.30?

**To assess hepatic status:**

Determine whether or not scleral icterus or other evidence of clinical jaundice is present. If there is no evidence of jaundice, enter a score of zero for the jaundice sub-score. If scleral icterus or other evidence of clinical jaundice is present, enter "3" for the Jaundice (row 2) sub-score.

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3. $SpO_2/FiO_2$ ratios correlate with $PaO_2/FiO_2$ ratios in which $PaO_2$ is obtained from arterial blood gas measurements. Rice TW, Wheeler AP, Bernard GR et al. Chest 2007;132(2):410-417.

**To assess circulatory status:**

Determine mean arterial blood pressure (MAP) in mm Hg, calculated as diastolic BP + 1/3(systolic BP – diastolic BP).

Obtain current dosage of any pressor medications in micrograms/kg/min.

Based on this information, determine and enter the Hypotension (row 3) sub-score.

Practice Questions

5) Let's say you have a 100kg patient come in with a blood pressure of 104/56. What is the patient's MAP, and what would be the Hypotension sub-score?

6) Now let's say that same patient is on 15 mcg/min of norepinephrine. Would this change the Hypotension sub-score, and if so, what would it be?

**To assess level of consciousness:**

Use the Glasgow Coma Scale[4] (GCS) (Appendix 2) to assess a patient's eye opening, verbal, and motor responses. Based on these responses, calculate a GCS score. In accordance with how the MSOFA was validated, for intubated patients, assign a verbal score based on the best verbal response observed, this might include writing messages or mouthing words around an endotracheal tube. When patients are sedated, give a "holiday" from sedation at least once every 24 hrs., calculate the GCS sub-score during that time, and record the best (highest) GCS score in that 24-hour period.

In validating MSOFA, Grissom et al. assigned GCS scores for patients on neuro-muscular blockade based on exam findings even during paralysis. In other words, if a patient is intentionally paralyzed using medication, and has been so for >24 hrs., the GCS score would be "3".

Next, use the GCS score you have calculated and the MSOFA scoring matrix to determine the Glasgow Coma Score sub-score (row 4), and enter it. For example, if the GCS score you calculated on exam is a "3", that corresponds to a row 4 sub-score of "4". If the GCS score on exam was "11" the row 4 sub-score would be a "2."

Practice Questions

7) You are evaluating a patient in the ICU who is heavily sedated and has been paralyzed for the past two days through use of a neuro-muscular blocking agent while on a ventilator. The person is non-verbal, doesn't open her eyes spontaneously or with provocation, and does not move, even in response to a painful stimulus. What Glasgow Coma Sub-score should you assign?

8) You see this patient again a week later. She is no longer receiving neuro-muscular blockade or sedation, but is still intubated. She makes no effort to communicate in any way and makes no spontaneous movements or response when people speak to her, but withdraws and blinks when an IV catheter is placed. Based on the MSOFA scoring matrix, what would her Glasgow Coma sub-score be?

4. The GCS can also be found at: https://www.cdc.gov/masstrauma/resources/gcs.pdf

**To assess renal status:**
If timely assessment of serum creatinine is available, obtain creatinine in mg/dL. You can then use this value to assign a renal (row 5) sub-score, based on the MSOFA scoring matrix.

**N.B. MSOFA has been validated using results from creatinine testing, but not using 24-hour urine output to assign renal sub-scores.** MSOFA lists 24-hour urine outputs that might be used to assign a renal sub-score *when creatinine results are not available*. **However, Oregon Crisis Care Workgroup members note that use of MSOFA in the absence of creatinine testing has not been studied.**

Practice Questions

9) Point-of-care testing is available, and you get a creatinine value of 2 mg/dL. What would be the corresponding MSOFA renal sub-score?

10) No creatinine testing is available. You are evaluating a 40 year old patient who sustained a severe crush injury involving the left leg 4 days ago. He was brought in from an alternate care site for possible admission due to decreased level of consciousness, fever to 101.5º, and recent swelling and increased warmth in the injured leg. You ask the Alternate Care Site staff person who accompanies him about the patient's urine output. She replies that this is not being formally tracked at the site, but she doesn't remember him voiding since she assumed his care 8 hours ago. Catheterization produces 100ml of cola-colored urine. Based on the information available to you, what MSOFA renal sub-score would you assign, if any?

## Calculating the MSOFA Score

Add the row scores together. This gives you the MSOFA Score.

## Case Studies to Gain Familiarity with Use of the Modified Sequential Organ Failure Assessment

### Scenario 1

Without warning, a magnitude 8.5 earthquake strikes 20 miles off Oregon's coast. All major highways, airports and bridges west of the Cascades are severely damaged and unusable. In Portland 2,500 people die within minutes. Another 15,000 are also injured, many seriously enough to need hospital care.

The Governor declares a disaster and after consultation with surviving representatives of the healthcare community, the Public Health Director activates Crisis Care Guidelines. Efforts to expand surge capacity are in place. However, critical care capacity is overwhelmed by the number of severely injured patients presenting for care, and it is not possible to transfer to unaffected facilities. You are serving as critical care triage officer at your hospital. The number of presenting, critically ill patients far exceeds available ICU bed space and your medical team and ethics committee agree that MSOFA scores may be helpful in prioritizing access to critical care resources.

#### Patients to Be Evaluated

Patient A: 46 yo male extricated after building collapse. Brought in by ambulance. Lacerations of scalp and face, diminished breath sounds on left. The patient is anicteric, but unresponsive, even with a painful stimulus, other than blinking and extension of the extremities. Pulse is 110, blood pressures are in the 110/60 range. He was intubated in field to protect his airway, and is maintaining $O_2$ Saturations above 94% without supplemental oxygen. He is catheterized with return of 450 cc of straw-colored urine that is negative for blood and has a specific gravity of 1.010 on dipstick. Creatinine testing is not available.

Patient B: 21 yo female who presents with neck trauma sustained in a building collapse. Left facial laceration, large penetrating wound on left lateral neck, ecchymosis of her left chest, and comminuted fractures of left humerus, radius and ulna. She moans when stimulated, but is otherwise non-verbal. She does not open her eyes but attempts to withdraw her arm when an IV catheter is placed. She has received several liters of crystalloid. Pulse is 140, blood pressure is currently 90/42 without vasopressors, and she is oxygenating well without supplemental $O_2$. She is not jaundiced; BUN and creatinine are 76 and 1.8, respectively.

Patient C: 35 yo female presents unconscious and completely unresponsive to stimuli after being pinned under a large pillar that fell across her midsection. She is pale, has a weak, thready pulse of 150, unobtainable blood pressure, and a distended abdomen without tympany to percussion. There is substantial ecchymosis over her right flank. Breath sounds are absent on the right, and her oxygen saturation is 93% on 8 L/min. by mask. She does not have any jaundice, but hepatic laceration with extensive internal bleeding is suspected. Insertion of a foley catheter results in passage of 550 ml of urine. Creatinine is 1.1mg/dl.

Patient D: This 68 yo female was the driver of a 1963 Corvair that crashed at the time of the initial quake. She was pinned between the steering wheel and the seat. She was intubated in the field. Creatinine is 2.1. While she is not jaundiced, when asked where she has pain, she points, indicating pain in the right upper quadrant and a broad band across her entire anterior chest. She gestures, asking for something to write with, and writes “Car totaled?” on a white board. Breath sounds are diminished bilaterally, and she is maintaining $O_2$ saturations in the high 80s on maximal oxygen.

Patient E: 33 year old male with type 1 diabetes and hypertension treated with lisinopril. He has just arrived by ambulance after being dug out of an apartment building damaged in the initial quake. He is anicteric, but somewhat pale. In addition to multiple contusions of the trunk and extremities, his right leg has been severed at the mid-shin. Blood glucose reads “high” on a hand-held glucose monitor, and he complains of thirst. He is oriented, answers questions, and helps, albeit clumsily, with his transfer to an ER bed. Though breathing rapidly, he has an $O_2$ saturation of 98% without supplemental oxygen. His blood pressure is 98/52. He has received a liter of fluid since extrication. He reports voiding several times while trapped, but does not remember specifics of timing or amount. Creatinine testing is not available.

## Scenario 2

In another part of the world, large numbers of people become very sick with respiratory illness. Many have died. The CDC confirms that the illness is a new form of influenza. It spreads rapidly around the world, arriving in Oregon three weeks later. Statewide, 44,000 people have become ill with the infection and 870 have died.

Many hospital staff members are out sick, making it difficult to care for patients. It isn't possible to transfer patients to other hospitals to relieve the burden, because all communities are affected. The Public Health Director at Oregon Public Health Division, in consultation with the healthcare community, declares a public health emergency and implements Crisis Care Guidelines. You have two critical care beds available at your facility, and multiple patients are awaiting evaluation for critical care admission. As triage officer, you determine MSOFA scores for each adult patient to help guide critical care resource allocation.

### Patients to Be Evaluated

Patient A: A 32 yo female arrives with high fever, cough, severe dyspnea, and cyanosis. Blood pressure is 92/50. She is conscious and looks at you when you talk to her, but she gives confused responses. She is able to write down the phone number for her husband, so he can be contacted. Oxygen saturation is at 82% on maximal $O_2$ by non-rebreather mask. Creatinine is 1.0. She is not icteric, and, when asked, reports she voided a normal amount (for her) shortly before her breathing became worse this a.m.

Patient B: A 66 yo female with long-standing hypertension, a 45 pack-year smoking history, coronary artery disease, and congestive heart failure presents with new-onset dyspnea at rest, 10 pound weight gain in the past week, and bilateral lower extremity edema extending to the knee. She is anicteric, alert and oriented, but appears anxious. On auscultation, she has an irregular rhythm with a heart rate, as near as you can tell, of about 150. Her blood pressure is 140/70. She has been taking her lisinopril, furosemide, and bumetanide as prescribed, and reports voiding several times a day. Creatinine is 2.8.Oxygen saturation is 91% on 4L/min. by nasal cannula.

Patient C: This 36 yo woman developed fever to 103º, cough, and sore throat earlier this morning, She arrives in status epilepticus. There is no evidence of jaundice. Though she is completely unresponsive and has no control of motor function, her eyes are open and deviated to the left. She appears to have been incontinent of a large amount of urine during the course of her seizure. Creatinine is 0.8 mg/dl. $O_2$ saturation is 88% on 12 L/min. by mask, and you are considering intubation. Blood pressure is 88/58.

Patient D: This 52 yo, 70 kg male is received in transport from a small rural hospital. He was under care there for meningococcal sepsis and his condition has worsened, prompting transfer. He is intubated and completely unresponsive on arrival, although this may be due, in part, to medical sedation. He is maintaining an oxygen saturation of 92% on a fraction of inspired oxygen of 0.6. He is on vasopressin and a norepinephrine drip at a rate of 10µg/min., but blood pressure remains in the 84/50 range. He has grown jaundiced since last evening, has generalized edema, and has reportedly been anuric for the last 16 hours, despite several boluses of furosemide.

## You also re-evaluate patients currently receiving critical care. These include:

Patient E: This 60 yo female without remarkable past medical history has been in the ICU for five days with ARDS due to influenza. Though on a ventilator, she is reasonably alert, takes an active role in facilitating bedpan use and sponge baths, and communicates using handwritten notes. She remains well hydrated; urine output is 32ml/hr, and creatinine is 0.7. She has no sign of jaundice. Pulse is 105, while BP is 130/68. She is on 5 of PEEP, and is requiring an $FiO_2$ of 0.3 to maintain an oxygen saturation of 95%.

Patient F: This 4 yo male was admitted two days ago with seizure and decreased level of consciousness in association with influenza infection. The child makes no response, even to painful stimuli. He is on a ventilator and, though maintaining high oxygen saturations on 0.3 $FiO_2$, makes no effort at spontaneous respirations. He is normotensive and anicteric, and making 30cc/hr. of urine.

Patient G: A 71 yo, 180 lb. gentleman with history of COPD has been hospitalized on a ventilator for 12 days due to influenza pneumonitis complicated by *Klebsiella* superinfection. He is on 16 of PEEP, his oxygen saturation is 88% on maximal oxygen. He has been medically sedated and is not responsive, However, when sedation is stopped, he opens his eyes when spoken to and attempts to pull his ivs out. Earlier in the hospitalization, he communicated using a white board, but now only draws squiggles when offered a board during sedation holidays. Urine output, despite ongoing IV hydration, is 5cc/hr. Creatinine is 5.2. He is on dopamine 20 mcg/min. and norepinephrine 10mcg/min. for blood pressure support. No jaundice.

## Answers to Practice Questions

Question 1. Based on the MSOFA scoring matrix, a person requiring 8L/min. of supplemental $O_2$ to maintain sats above 90% would get a respiratory sub-score of "3."

Question 2. A person with $O_2$ saturations above 90% on room air would have a respiratory sub-score of "0."

Question 3. If a ventilated patient has an SpO2 of 82% on an $FiO_2$ of 0.95, we've got trouble: 82/0.95 = 86. This is less that 150, and, based on the MSOFA scoring matrix, the respiratory sub-score would be "4."

Question 4. Someone with an $SpO_2$ of 98% on an $FiO_2$ of 0.30 is in better shape: 98/0.3 = 327, corresponding to a respiratory sub-score of "1."

Question 5. With a blood pressure of 104/56, this person's mean arterial pressure would be 56 + (104 – 56)/3. In other words, 56 + (48)/3 which equals 56 + 16. Adding these together gives an MAP of 72. Looking at the MSOFA scoring matrix, this corresponds to a Hypotension sub-score of "0."

Question 6. The patient is on pressors, which does, indeed, change the picture. If a person is on pressors, the Hypotension sub-score is determined by the extent of pressor support, not by MAP. In a 100kg person, 15 mcg/min. of norepinephrine represents a dose of 0.15 mcg/kg/minute. Based on the MSOFA scoring matrix, this person's circulatory sub-score would be "4."

Question 7.This is a question on which reasonable people might disagree. On the face of it, this person's Glasgow Coma Score, with no motor activity, verbal activity, or eye opening, would be 3, resulting in a Glasgow Coma MSOFA sub-score of "4." Of course, neuro function would likely be better off of sedation and neuro-muscular blocking agents. Still, assuming normal neuro function in this situation could lead to under-triage. Grissom et al. recommend giving patients a "sedation holiday" at least once every 24 hours to assess neurologic status, and using the best GCS score in the prior 24 hours to calculate the MSOFA GCS sub-score. Nonetheless, if a patient is paralyzed through neuro-muscular blockade for more than 24hrs., the validated approach is to assign the GCS sub-score based on the actual exam findings.

Question 8. The patient opens her eyes only in response to pain, giving her a GCS verbal score of 2, She also withdraws her arm in response to pain, so she would get a GCS motor score of 4. Based on the absence of any attempt at communication, her verbal score would be one. Adding these up gives a Glasgow Coma Score of 7. Based on the MSOFA scoring matrix, her Glasgow Coma sub-score would be "3."

Question 9. Using the scoring matrix, a serum creatinine of 2 mg/dL would correspond to an MSOFA renal sub-score of "2."

Question 10. Use of the MSOFA in the absence of creatinine measurement has not been validated. In any case, if we assume that the ACS staff person is correct, the patient hasn't voided in at least 8 hours, and he has only 100cc of urine in his bladder; the situation doesn't sound particularly good.

## Scoring and Comments for Scenario Patients

### Scenario 1

| | | |
|---|---|---|
| Patient A: | $O_2$ sat. is > 90% on room air. | Respiratory sub-score=0. |
| | No jaundice. | Jaundice sub-score=0. |
| | Hypotension not present. | Hypotension sub-score=0. |
| | GCS score is 5. | GCS sub-score=4. |
| | Use of MSOFA in absence of creatinine measurement has not been validated. | |
| Patient B: | Oxygenating well on room air. | Respiratory sub-score=0. |
| | No jaundice. | Jaundice sub-score=0. |
| | MAP is ~58. | Hypotension sub-score=1. |
| | GCS score is 7. | GCS sub-score=3. |
| | Creatinine is 1.8. | Renal sub-score=1. |
| | MSOFA score is 5 | |
| Patient C: | Needs 8L/min. to keep $O_2$ sat.>90 | Respiratory sub-score=3. |
| | No jaundice. | Jaundice sub-score=0. |
| | MAP<70. | Hypotension sub-score=1. |
| | GCS score is 3. | GCS sub-score=4. |
| | Creatinine <1.2. | Renal sub-score=0. |
| | MSOFA score is 8. | |
| Patient D: | $O_2$ sat.<90 on maximal $O_2$ | Respiratory sub-score=4. |
| | No jaundice. | Jaundice sub-score=0. |
| | Hypotension not present. | Hypotension sub-score=0. |
| | GCS score is 15. | GCS sub-score=0. |
| | Creatinine >2.0 and <3.5. | Renal sub-score=2. |
| | MSOFA score is 6. | |
| Patient E: | Oxygenating well on room air. | Respiratory sub-score=0. |
| | No jaundice. | Jaundice sub-score=0. |
| | MAP<70. | Hypotension sub-score=1. |
| | GCS score is 15. | GCS sub-score=0. |
| | Sounds like he's voiding. . . but use of MSOFA in absence of creatinine measurement has not been validated. | |

## Scenario 2

| | | |
|---|---|---|
| Patient A: | $O_2$ sat.<90 on maximal $O_2$ | Respiratory sub-score=4. |
| | No jaundice. | Jaundice sub-score=0. |
| | MAP<70. | Hypotension sub-score=1. |
| | GCS score is 14. | GCS sub-score=1. |
| | Creatinine <1.2. | Renal sub-score=0. |
| | MSOFA score is 6. | |
| Patient B: | Needs 4L/min. to keep $O_2$ sat.>90 | Respiratory sub-score=2. |
| | No jaundice. | Jaundice sub-score=0. |
| | Hypotension not present. | Hypotension sub-score=0. |
| | GCS score is 15. | GCS sub-score=0. |
| | Creatinine between 2.0 and 3.4. | Renal sub-score=2. |
| | MSOFA score is 4. | |
| Patient C: | $O_2$ sat.<90 on maximal $O_2$ | Respiratory sub-score=4. |
| | No jaundice. | Jaundice sub-score=0. |
| | MAP<70. | Hypotension sub-score=1. |
| | GCS score is 3. | GCS sub-score=4. |
| | Creatinine <1.2. | Renal sub-score=0. |
| | MSOFA score is 9. | |
| Patient D: | $O_2$ sat./$FiO_2$ in 151-230 range. | Respiratory sub-score=3. |
| | Jaundice present. | Jaundice sub-score=3. |
| | Norepi dose > 0.1mcg/kg/min. | Hypotension sub-score=4. |
| | Better to evaluate patient off sedation, but, given scenario, one can't. Need to do best assessment possible under the circumstances based on objective information. GCS score is 3. | GCS sub-score=4. |
| | While use of MSOFA in absence of creatinine measurement hasn't been validated, things are clearly not looking good. | |
| Patient E: | $O_2$ sat./$FiO_2$ in 316-400 range | Respiratory sub-score=1. |
| | No jaundice. | Jaundice sub-score=0. |
| | Hypotension not present. | Hypotension sub-score=0. |
| | GCS score is 15. | GCS sub-score=0. |
| | Creatinine <1.2 . | Renal sub-score=0. |
| | MSOFA score is 1. | |
| Patient F: | Given the patient's age, MSOFA would not be used in evaluation. | |
| Patient G: | $O_2$ sat.<90 on maximal $O_2$ | Respiratory sub-score=4. |
| | No jaundice. | Jaundice sub-score=0. |
| | Norepi dose > 0.1 mcg/kg/min. | Hypotension sub-score=4. |
| | GCS score is 9-10 (opens eyes to greeting, purposeful actions. Use of white board hard to interpret. | GCS sub-score=2 or 3. |
| | Creatinine >5. | Renal sub-score=4. |
| | MSOFA score is 14 or 15. | |

## *Appendix 1:* ***Modified Sequential Organ Failure Assessment (MSOFA)***

MSOFA requires one lab value (creatinine), which can be obtained using bedside point-of-care testing (for example, using i-STAT). MSOFA has not been validated in children, nor has it been validated with use of urine output to assess renal status.

| **MSOFA Scoring Guidelines** | | | | | | |
|---|---|---|---|---|---|---|
| Variable | Score 0 | Score 1 | Score 2 | Score 3 | Score 4 | Score for each row |
| **$SpO_2/FiO_2$ ratio*** *or* nasal cannula or mask $0_2$ required to keep $Sp0_2$ >90% | $SpO_2/FiO_2$ >400 *or* room air $SpO_2$ >90% | $SpO_2/FiO_2$ 316-400 *or* $SpO_2$ >90% at 1-3 L/min | $SpO_2/FiO_2$ 231-315 *or* $SpO_2$ >90% at 4-6 L/min | $SpO_2/FiO_2$ 151-230 *or* $SpO_2$ >90% at 7-10 L/min | $SpO_2/FiO_2$ ≤150 *or* $SpO_2$ >90% at >10 L/min | |
| **Jaundice** | no scleral icterus | | | clinical jaundice or scleral icterus | | |
| **Hypotension†** | None | MAP<70 | dop<5 | dop 5-15 *or* epi ≤0.1 *or* norepi ≤0.1 | dop >15 *or* epi >0.1 *or* norepi >0.1 | |
| **Glasgow Coma Score** | 15 | 13-14 | 10-12 | 6-9 | <6 | |
| **Creatinine level, mg/dL** (can use i-STAT) | <1.2 | 1.2-1.9 | 2.0-3.4 | 3.5-4.9 *or* urine output <500 mL in 24 hours | >5 *or* urine output <200 mL in 24 hours | |
| | | | | | **MSOFA score = total scores from all rows:** | |

* *$SpO_2/FiO_2$ ratio:*

$SpO_2$ = Percent saturation of hemoglobin with oxygen as measured by a pulse oximeter and expressed as % (e.g., 95%)

$FiO_2$ = Fraction of inspired oxygen; e.g., ambient air is 0.21

Example: if $SpO_2$=95% and $FiO_2$=0.21, $SpO_2/FiO_2$ ratio is calculated as 95/0.21=452

† Hypotension:

MAP = mean arterial blood pressure in mm Hg (diastolic + 1/3(systolic - diastolic)) dop= dopamine in micrograms/kg/min

epi = epinephrine in micrograms/kg/min

norepi = norepinephrine in micrograms/kg/min

*Adapted from: Grissom CK, Brown SM, Kuttler KG, et al. Disaster Med Public Health Preparedness. 2010;4:277-284.*

# Appendix 2**: Glasgow Coma Scale**

**Eye Opening Response**

- Spontaneous--open with blinking at baseline **4 points**
- To verbal stimuli, command, speech **3 points**
- To pain only (not applied to face) **2 points**
- No response **1 point**

**Verbal Response**

- Oriented **5 points**
- Confused conversation, but able to answer questions **4 points**
- Inappropriate words **3 points**
- Incomprehensible speech **2 points**
- No response **1 point**

**Motor Response**

- Obeys commands for movement **6 points**
- Purposeful movement to painful stimulus **5 points**
- Withdraws in response to pain **4 points**
- Flexion in response to pain (decorticate posturing) **3 points**
- Extension response in response to pain (decerebrate posturing) **2 points**
- No response **1 point**

*Source: Centers for Disease Control and Prevention. Accessed Jul. 23, 2015 at:*
http://www.cdc.gov/masstrauma/resources/gcs.pdf