

REVIEW

Clinical review: Considerations for the triage of maternity care during an influenza pandemic - one institution's approach

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Abstract

The ongoing pandemic of 2009 H1N1 swine-origin influenza A has heightened the world's attention to the reality of influenza pandemics and their unpredictable nature. Currently, the 2009 H1N1 influenza strain appears to cause mild clinical disease for the majority of those infected. However, the risk of severe disease from this strain or other future strains remains an ongoing concern and is noted in specific patient populations. Pregnant women represent a unique patient population that historically has been disproportionately affected by both seasonal and pandemic influenza outbreaks. Data thus far suggest that the current 2009 H1N1 outbreak is following this same epidemiologic tendency among pregnant women. The increased predilection to worse clinical outcomes among pregnant women has potential to produce an acute demand for critical care resources that may overwhelm supply in facilities providing maternity care. The ability of healthcare systems to optimize maternal-child health outcomes during an influenza pandemic or other biologic disaster may therefore depend on the equitable allocation of these limited resources. Triage algorithms for resource allocation have been delineated in the general medical population. However, no current guidance considers the unique aspects of pregnant women and their unborn fetuses. An approach is suggested that may help guide facilities faced with these challenges.

Introduction

The ongoing 2009 H1N1 influenza pandemic highlights the inherent tendency of the influenza virus to mutate,

produce novel strains, and infect large segments of the population in a relatively short period of time. Since the first notification of the novel 2009 H1N1 strain causing human disease in April 2009, the World Health Organization has reported more than 300,000 confirmed human cases in nearly all geographic areas of the world, and a pandemic was accordingly declared in June 2009 [1]. In addition, the Centers for Disease Control and Prevention estimate that at least 60 million Americans have been infected with this virus since its recognition [2]. It is projected that ongoing infection and associated morbidity from this strain will continue for the foreseeable future and mass vaccination programs have thus been undertaken. Despite the rapid and widespread dissemination of the virus, thus far most of those infected have suffered mild clinical illness with the overall mortality rate at less than 1% (approximately similar to seasonal influenza) [1,2]. It is not clear, however, how the virulence of the current strain will alter over time. In addition, certain populations appear to be suffering in a disproportionate manner [1,2].

Previous influenza pandemics have repeatedly documented disproportionate morbidity and mortality among pregnant women, with mortality rates of two to four times the same age adult non-pregnant population [3]. Emerging data from the current pandemic validate the vulnerable population status of pregnant women by demonstrating an increased likelihood (five to ten times) of hospitalization and death among pregnant women [4]. Consistent with previous projections and current data, people younger than 40 years of age, pregnant women, and those with underlying medical illnesses are at highest risk for severe infection from this novel strain [1-4]. At any given time, pregnant women comprise approximately 1% of the population. However, thus far it appears that they are responsible for approximately 5 to 10% of the hospitalizations and deaths from H1N1 in any one locale [4]. This approximate five- to ten-fold discrepancy could place much larger strains on hospitals that would have to provide for an increased number of critically ill pregnant women simultaneously converging on medical facilities

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and requiring critical care resources, such as ventilators. Determination of an ethically sound triage process to delineate use of ventilators for this population is an important component of pandemic influenza preparedness planning and management.

The numerous challenges posed by wide-scale infectious disease epidemics such as influenza pandemics and the various ethical paradigms for resource allocation during these events have been delineated in the published literature [5-9]. A similar document also outlines the unique ethical challenges presented by pregnancy [10]. The medical literature also includes logistical guidance as to how to approach this dilemma for the general medical population but no such guidance exists for the pregnant population that considers their unique characteristics and needs. Such needs include, but are not limited to, changing priorities and clinical scenarios depending on gestational age, alteration of some of the evaluated physiologic parameters, and consideration of another individual, the developing fetus and/or neonate.

The overall aim of this paper is to review the medical literature on this timely subject and delineate a prioritization schema for ventilator (or other resources) triage and allocation based on principles that are useful to facilities providing obstetrical care, either in isolation (free-standing maternity hospital) or as part of a large multidisciplinary acute-care facility. This document would have the goal of benefiting the greatest number of prospective mothers and newborns, minimizing morbidity, and improving overall survival among this unique patient population. It is recognized that individual institutions usually do not develop such guidelines in isolation. However, given the unique characteristics of the pregnant population and the recognized need for a functional logistical approach, this document was generated.

Methods

A literature search was performed using widely available search engines PubMed and Medline from 1966 until the present. Keywords used included: triage, pandemics, influenza, limited resources, critical-care, and pregnancy. Listed articles were then reviewed for relevance to the topic covered herein. When articles appeared to be relevant, full citations were then accessed and reviewed in their entirety. After review of potential applicable manuscripts, seven documents were identified that delineated medically specific logistical approaches with algorithms to the triage of limited medical resources and those were used as a foundation for these considerations [11-17].

After identification of these relevant paradigms, the Magee-Womens Hospital of the University of Pittsburgh Medical Center Ethics Committee considered the issue for 20 months from January 2008 through August 2009. Magee-Womens Hospital is part of a large medical

system (The University of Pittsburgh Medical Center) of 18 hospitals providing a large share of the medical services in the southwestern Pennsylvania region. Throughout the process of quarterly meetings, numerous issues and perspectives were considered and discussed: members of various clerical denominations presented religious views on relevant medical ethics, bio-ethicists shared their expertise, physicians from multiple specialties, nurses, and senior hospital administration presented their respective perspectives, and members of the lay community also shared their thoughts. A final document emerged (presented herein) with agreed upon broad principles and specific algorithms that will function for any upcoming disasters, including the current 2009 H1N1 influenza pandemic. The value of the multidisciplinary input (and their variable perspectives) to the deliberations and the final product cannot be overemphasized. In formulating the final plan it is acknowledged that such a plan serves as a template only and is unable to anticipate every possible situation in advance. Thus, the final product is presented as a guidance document for other facilities providing maternity care. This document provides a foundational approach to these challenges but also allows for ongoing situational refinement in the face of real disaster, its respective specifics, and the appropriate facility-specific alterations.

Before the initiation of use of this protocol the local public health authorities as well as the hospital system leadership would be consulted for input. A collaborative investigation into the existence of regional opportunities to assist and obviate the need to use this protocol would be undertaken. However, if no other options existed, the protocol would go into effect in collaboration with both the public health authorities and hospital system leadership to augment the ability to assess ongoing and future necessity of the protocol given the disease-specific characteristics (such as waning local disease activity).

Foundational concepts

In order to begin conceptualization of how to triage and allocate limited resources in a maternity setting, a number of concepts were delineated in advance of the acute necessity, using the venue of our hospital ethics committee. It is believed that having these concepts delineated in advance of a disaster will allow for a systematic and effective use of the proposed schema without having to re-consider these issues in the face of the epidemic. The suggested concepts that were derived and are to be used when faced with resource limitations are listed in Table 1. The listed exception of consideration of a prospective patient's role in society as a relevant factor for prioritizing limited resources (being a health care worker that delivers direct patient contact) deserves explanation. This issue was deliberated extensively by the

Table 1. Foundational concepts for maternity prioritization and allocation schema

Gravidity and parity are not considered for priority
A pregnant woman's 'role in society' is not considered Exception is health care workers providing direct patient care
No value judgments (and thus alterations in priority status) are considered on socioeconomic or lifestyle specifics of each patient
To be considered in the maternity schema the women must have a clinically confirmed and presently viable pregnancy: Usual clinical parameters confirming pregnancy (that is, auscultation of fetal heart tones by medical provider, obvious uterine enlargement due to a fetus, visible fetal movement, and so on) Ultrasound documentation of intrauterine pregnancy
Pregnant women with significant medical comorbidities may receive lower priority than those without (may 'screen out' when applying clinical exclusion criteria)

committee due to its importance. This decision to prioritize health care workers was made given the realization of their vital role in care provision for all as well as the recognized need to provide reassurance to health care workers in order to maintain a functional workforce during the disaster. It is recognized that without a sustained workforce, care provision would be further compromised, threatening the fulfillment of the facility mission.

Triage schema

The foundational approach taken by the proposed algorithm is a prioritization schema that aims to provide the limited resources to those that have the best chance of benefiting from these resources. Thus, the grading of prioritization status depends on the status of the patient at the time of resource allocation. A proposed method and frequency of reevaluation of status after receipt of resources is addressed later in the document. However, qualification for the limited resource focuses on status at presentation.

In order to allocate the limited resources to those most able to benefit, a schema that grades health status is required. There are two components of such a schema: overall health status of each patient previously present and independent of the acute disease process caused by the current outbreak; and current acute status of the patient graded objectively using previously validated critical care criteria (Sequential Organ Failure Assessment scoring, or SOFA score) [18]. Christian and colleagues proposed this scoring system to the current application, and many components of this protocol are modeled from their proposal [13]. Note that the physiologic parameters in the validated SOFA score are graded for the general medical population. Where the few pregnancy-specific adaptations have been made it will be noted (lower creatinine cutoff levels and platelet counts in women with hypertensive disorders of pregnancy). It is recognized that making minor modifications to the specific criteria cutoff points of the laboratory parameters of the SOFA scoring has not been validated for use in pregnant women. However, these are pregnancy-specific alterations that make the scoring

algorithm more relevant to this patient population given known physiologic changes of pregnancy. Furthermore, it is unlikely that validation of the minor changes due to pregnancy specifics will be performed in a timely fashion or that these small alterations will affect the validity of the schema.

To begin to use the algorithm the first required step for each patient to assign priority is to assess patient need by applying the proposed inclusion criteria. In order to be eligible for receipt of a limited resource, each woman must meet the inclusion criteria by having the following clinical circumstances: clinically confirmed and viable pregnancy (defined in Table 1); and clear, documented need for the limited resource (for ventilation, refractory hypoxemia, respiratory acidosis (pH <7.25), impending respiratory failure and/or evidence of inability to protect the airway; for other critical care resources, clinically apparent hypotensive shock that is unresponsive to fluid resuscitation and requires the use of vasoactive medications that cannot be given on regular hospital units).

It is recognized that the above parameters may appear to set the threshold too low for intervention in pregnant women. However, the indications for mechanical ventilation and/or other critical care resource are nearly identical in pregnancy when compared to non-pregnant patients. After each woman is considered eligible for receipt of a limited resource based on fulfilling the above criteria, they are then evaluated for the presence of any exclusion criteria. The presence of any exclusion criteria makes them ineligible for allocation of the limited resource at the present time. The exclusion criteria are listed in Table 2. This list includes some relevant alterations to previously proposed exclusion criteria by Christian and colleagues [13] given the likelihood of pregnant women's underlying clinical illness predating the need for critical care resources.

If no exclusion criteria exist, each woman then enters into the protocol for prioritization. This evaluation is based on the SOFA scoring system. This is a cumulative scoring system that sums the individual scores for each of the parameters noted to be relevant for the prediction of critical care outcomes (Table 3). Points are assigned based on clinical status of each patient and then the

Table 2. Exclusion criteria for critical care resource consideration

Severe trauma victim (otherwise precluding normal care)

Suffered from severe burns with either of these two criteria:
 40% burn of total body surface area
 Inhalation injury

Cardiac arrest (ongoing at time of evaluation)

Severe baseline cognitive impairment
 Defined as requiring regular ongoing assistance from others

Advanced significant and/or untreatable neurological disease with major functional impairment

Presence of metastatic and/or terminal cancer

Advance immunocompromised state, for example:
 End-stage renal disease
 AIDS
 Status post-organ transplant requiring ongoing immunosuppressive therapy

Evidence of end-stage organ failure:
 Heart: NYHA class 3 or 4 heart failure
 Lungs: COPD requiring chronic oxygen therapy, cystic fibrosis with baseline PaO₂ <55 mmHg, primary pulmonary hypertension with pulmonary arterial pressure >50 mmHg
 Liver: current liver failure or chronic liver disease with Child-Pugh score ≥7
 Kidney: renal failure requiring dialysis

COPD, chronic obstructive pulmonary disease; NYHA, New York Heart Classification. Adapted with permission from [13].

Table 3. SOFA score parameters [18]

Clinical parameter	Score				
	0	1	2	3	4
PaO ₂ /FIO ₂ , mmHg	>400	≤400	≤300	≤200	≤100
Platelet count, × 10 ⁶ /L ^a	>150	≤150	≤100	≤50	≤20
Bilirubin, mg/dl	≤1.2	1.2-1.9	2.0-5.9	6.0-11.9	>12
Hypotension	None	MAP <70	Dopamine ≤5 ^b	Dopamine >5 ^b Epinephrine ≤0.1 ^b Norepinephrine <0.1 ^b	Dopamine >15 ^b Epinephrine >0.1 ^b Norepinephrine >0.1 ^b
Glasgow Coma Score	15	13-14	10-12	6-9	<6
Creatinine level (mg/dl) ^c	<1.0	1.0-1.7	1.8-3.2	3.3-4.7	>4.8

^aPlatelet count considered to be due to primary condition necessitating scoring algorithm and not due to pregnancy-induced hypertension. ^bIn micrograms/kg/minute. ^cAll creatinine levels are 0.2 mg/dl lower here for pregnant patients than the general medical population given known physiologic changes of pregnancy. MAP, mean arterial blood pressure; SOFA, Sequential Organ Failure Assessment. Adapted with permission from [18].

summation gives a total score. Once these parameters have been assessed, numbers have been assigned, and cumulative scoring has taken place for all parameters, then total scoring will determine prioritization of one pregnant women over another. Suggested guidance on use of the cumulative scoring to determine prioritization is listed in Table 4.

The current schema delineates 'entry' into the algorithm for prospective patients. Given that clinical status is a dynamic process and resource needs and availability fluctuate, there also is a need to monitor the ongoing use and need for limited resources after allocation. Patients who have received the limited resources should be re-assessed approximately every 72 hours to determine clinical status after allocation. Table 5 includes proposed guidance on assessment of patient status at approximately

72 hour intervals and how to proceed. It is also important to note that if the need for limited resources is ongoing for patients previously scored at the lowest or intermediate priority, and who thus did not receive prioritization, scoring can be repeated to 're-prioritize' resources on an ongoing basis.

Making these decisions on a day to day basis requires a working group that is composed of individuals who understand the protocol and can apply the criteria daily. The group should consist of approximately three senior clinical individuals working together to make sound clinical assessments and allocation. Three clinicians allows for a full vetting of the relevant clinical issues, provides both obstetric and critical care input, and allows for majority decision making in rare cases of controversy that cannot be easily resolved by referring to the

Table 4. Guide to scoring interpretation

Category	Priority	SOFA score
Blue/black	Excluded from receipt of limited resources	>11 or previously excluded from exclusion criteria
Red	Highest priority for receipt of limited resources	≤7 or single-organ failure
Yellow	Intermediate priority for receipt of limited resources	8 to 11
Green	Lowest priority	No organ failure - does not need resources

Adapted from [13] with permission.

Table 5. Suggested guidelines for ongoing evaluation at 72 hour intervals

1	Patient demonstrating clear and unanimous clinical improvement after resource allocation Patient remains on ventilator (or other limited resource)
2	Patient demonstrating clear and unanimous worsening despite resource allocation and need still exists for limited resource by others Patient removed from limited resource and opportunity given to another prospective patient
3	Patient's clinical status equivocal despite resource allocation and need still exists for limited resource by others To be handled on a case-by-case basis

pre-defined criteria in the document. A suggested working group includes an experienced obstetric clinician, an experienced critical care clinician, and a senior obstetrical and/or critical care nursing representative. Modifications of this group to lesser numbers of individuals could be made dependent on the local capabilities to provide adequate numbers of senior clinicians. However, senior level clinicians are recommended given the added perspective that years of practice generally yield. In addition to this clinically active working group of N = 3, a 'high-ranking' committee (of clinicians and administrative personnel) should also be in place for the purpose of addressing challenging and/or contentious issues and situations brought to them by the previously defined working group that will likely arise after invoking such a protocol. Members of this 'high-ranking' committee could include a department chair of obstetrics and/or critical care, a chief medical officer, and hospital administrative leadership (president, or designee) and/or an expert in medical ethics. Valuable input from clergy can also be sought at the discretion of each facility for any and all challenging issues that may arise.

Alternative considerations

As a product of earlier deliberations and after experiencing the current and ongoing 2009 H1N1 influenza pandemic, further maternity-specific considerations were recognized and delineated and will be briefly reviewed.

When a decision is made to perform a premature iatrogenic delivery for maternal benefit it is suggested that it be done after consultation with the relevant neonatal ICU personnel to assure resources are available to manage the preterm neonate. Given similar vulnerabilities, it is likely that neonatal ICUs will also be simultaneously faced with limited resource decisions

during an influenza pandemic; thus, ongoing daily collaboration between obstetrics and neonatology services is required in order to optimize both maternal and neonatal outcomes. Once the mother is delivered, it is suggested that she now be considered not pregnant and still be considered for ongoing critical care resource use applying the same inclusion/exclusion criteria and 72 hour re-evaluation paradigm previously described herein.

When all other clinical parameters for prioritization are equal and two pregnant women are in need of the same resource, consideration should be given to the gestational age of the pregnancy as a potential prioritization cutoff. In this particular situation, facility-specific data may aid in determining a 'cut-point' at which time viability (the ability to be clinically managed and live after intensive interventions) of neonates may be expected. Pregnancies beyond the point of fetal viability may potentially receive higher priority given the fetus now has the ability to survive (with resource allocation) *ex utero*.

In addition, the value of ongoing open communication during infectious disease disasters between obstetricians, critical care clinicians, and infectious diseases specialists in each institution (and potentially between regional groups of similarly focused clinicians) cannot be over-emphasized. As these outbreaks evolve over time, lessons are learned that become directly applicable to the care of these critically ill pregnant women and affect the management and allocation decisions discussed in this paper. Lessons learned from different perspectives and potentially different regional institutions can be very helpful and provide valuable input that a single institution may not have insight into. This is especially true for critical care of the obstetric population as the experience of any one institution with large numbers of critically ill pregnant women may be relatively limited. Thus, advance consideration by each facility of establishing 'regional

consortiums' may be prudent to enhance the ability to optimize the care of such patients in the future.

Conclusions

Infectious disease disasters such as influenza pandemics have the potential to pose challenging scenarios in terms of resource allocation. The scenario of overwhelming demand for ventilators (or other critical care resources) that outstrips supply in a maternity setting is a contentious issue that deserves advance consideration given the ongoing 2009 H1N1 influenza pandemic. Pregnant women and their unborn fetuses present unique challenges in this regard. This algorithm provides an approach to delineate these challenges in an ethically sound manner. The goal of this proposed document is to maximize optimal outcomes and benefit the greatest number of prospective mothers and newborns, minimize overall morbidity, and improve overall survival among this unique patient population.

Abbreviations

SOFA, Sequential Organ Failure Assessment.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All authors (RB, JH, MB, and DE) contributed substantially to the intellectual content and presentation of this manuscript.

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