

The Future ICU

The Future of Haemodynamic Monitoring: From Planet Mars to Resource-Limited Countries, *F. Michard, M. Fortunato, A. Pratas, S. Rodrigues de Oliveira*

Clinical Decision Support Systems: Future or Present in ICU? *A. Naharro-Abellán, B. Lobo-Valbuena, F. Gordo*

The Future of Critical Care Ultrasound, *A. Butnar, A. Wong, S. Ho, M. Malbrain*

Future ICU Design: Return to High Visibility, *D. Hamilton, S. Swoboda, C. Cadenhead*

A Framework for Addressing Seasonal Influenza: A Critical Care Perspective, *L. Busse, C. Coopersmith*

Will Artificial Intelligence Change ICU Practice? *V. Herasevich, M. Keegan, M. Johnston, B. Pickering*

Future Strategies in Sedation and Analgesia, *B. Pastene, M. Leone*

Critical Care Telemedicine: A Management Fad or the Future of ICU Practice? *K. Iliopoulou, A. Xyrichis*

The Intersection of Big Data, Artificial Intelligence, Precision and Predictive Medicine to Create the Future of Critical Care, *G. Martin*

The Intelligent Intensive Care Unit: Integrating Care, Research and Education, *E. Cox, I. van der Horst*

PLUS

Introducing the Intubation Credit Card, *A. Higgs, S. Goodhand, A. Joyce*

Improving Recognition of Neonatal Sepsis, *M. Harris, A. Masino, R. Grundmeier*

Lifesaving Applications of Transoesophageal Echocardiography in Critical and Emergency Care, *R. Arntfield*

Shaping the Human Side of Medical Devices in Critical Care: The Implication of Human Factor Studies in Clinical Settings, *M. Micocci, A. Tase, M. Ni, P. Buckle, F. Rubulotta*

Diagnosis, Treatment and Management of the Critically Ill Patient, *R. Moreno*



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A Framework for Addressing Seasonal Influenza: A Critical Care Perspective

Seasonal influenza remains a significant health burden and places tremendous and predictable strain on personnel and resources within a health system, specifically within critical care. Despite this, many institutions do not have a comprehensive influenza management plan. Effective and comprehensive critical care management of influenza requires centralised oversight and coordination, a robust electronic health record system, and a set of system-based practices, including infrastructures and protocols, which will match the burden of influenza with available resources. Standardisation of diagnostic and therapeutic practice habits are required to support adequate collection and dissemination of data, which can inform the nature and adequacy of any proposed system-based practices. A framework for the comprehensive management of influenza is presented.

Introduction

Seasonal influenza can range from mild to severe disease, the latter of which has been described as disease requiring hospital or intensive care unit (ICU) admission (Amini et al. 2017; Ku et al. 2017; Fitzner et al. 2018). Influenza infection remains a significant global health burden, with the number of deaths estimated to be 300,000-600,000 per year, and the number of hospitalisations estimated at 3-5 million (Iuliano 2018). In the U.S., the 2017-2018 season saw the highest rate of illness (48.8 million influenza diagnoses, 22.7 million people seeking care, 959,000 hospitalisations, and 79,400 deaths) since the 2009 H1N1 pandemic, which estimated 60 million illnesses (Shrestha 2010). Though the percentage of patients diagnosed with influenza needing ICU admission remains small (approximately 20% of hospitalised patients), there is still a sizeable impact on

intensive care resources at many hospitals (Rodrigo et al. 2016; Hart 2018).

Despite this burden, rarely is influenza managed in a cohesive way within a health system, and levels of preparedness for outbreaks are poor (Gomersall et al. 2007). This is particularly frustrating given that influenza exerts a predictable seasonal strain on healthcare personnel and resources for four to six months out of the year. Moreover, the severity of any one influenza season is, at least in part, somewhat anticipated based on the seasonal effects felt in the opposite hemisphere (de Mello et al. 2009). As a contagion, influenza falls under the rubric of specialists in infectious disease. However, rarely is this specialty consulted in the management of hospitalised influenza patients. Severe influenza associated with organ failure certainly requires critical care, but milder cases are usually managed by the emergency department, internal medicine

(in the inpatient or outpatient setting), or at home by the patient. In short, no one specialty “owns” influenza, making recognition, diagnosis, coordination of care, and tracking (all of which are essential for a readiness plan) difficult. Tracking and reporting of seasonal influenza in the U.S. is estimated by the Centers for Disease Control and Prevention (CDC) and globally by the World Health Organization (WHO) (cdc.gov; who.int). Rarely, however, are local influenza patterns disseminated in a meaningful way down to the level of the ICU. At the level of the health system, tracking may be fragmented by location of patient interaction (the emergency department, the hospital ward, the intensive care unit) and patient disposition (admitted versus not admitted). Further complicating this, many health systems use multiple diagnostic modalities with duplicative efforts, and treatment algorithms also tend to be

inconsistent, particularly because antiviral therapy is only moderately helpful (Dobson et al. 2015).

The current standard of care, from a critical care perspective, includes vaccination, respiratory isolation pending diagnosis, initiation of antiviral treatment, support for specific organ failure, and then discharge from the ICU once symptoms have abated (Wieruszewski and Linn 2018; Uyeki et al. 2018; Cowling et al. 2009; Napolitano et al. 2014). Adjunctive therapies include corticosteroids, antimicrobials, and intravenous immunoglobulin (IVIg), though data is lacking as to effectiveness of these specific remedies (Rodrigo et al. 2016; Chong et al. 2011; Lee et al. 2017). Where current standards are deficient, however, is in the establishment of a comprehensive approach in the management of influenza, including standardised diagnostics and treatment algorithms, succinct tracking and reporting of the disease, and system-based efforts aimed at matching scarce resources with greatest needs. While all of these elements of a comprehensive approach transcend the specialty of critical care, there are some critical care-specific aspects that bear exploration, specifically with regard to oversight, data management and system-based practices.

A Framework

Effective, comprehensive critical care management of influenza is reliant on the precondition of centralised oversight and coordination of critical care efforts amongst the many different ICUs throughout a health system. While a formal critical care organisation can fulfil this role, any entity that allows for centralised management, efficient dissemination of information, and standardised workflow is suitable, and can be as simple as an ad-hoc influenza committee (Moore et al. 2018). Upon this platform, a robust electronic health record (EHR) system must be deployed in order to streamline diagnostics, treatment, data collection and analysis. Finally, built

upon all of these essential elements are a set of system-based practices, including infrastructures and protocols that are put in place to match the burden of influenza with available resources and a robust reporting system. A proposed framework is presented as **Figure 1**.

of choice (Uyeki et al. 2018).

A standardised approach at the system level, using one universally accepted diagnostic algorithm, is essential for the elimination of waste and to assist in data tracking. This practice should be supported by the availability of ancillary tests (e.g.

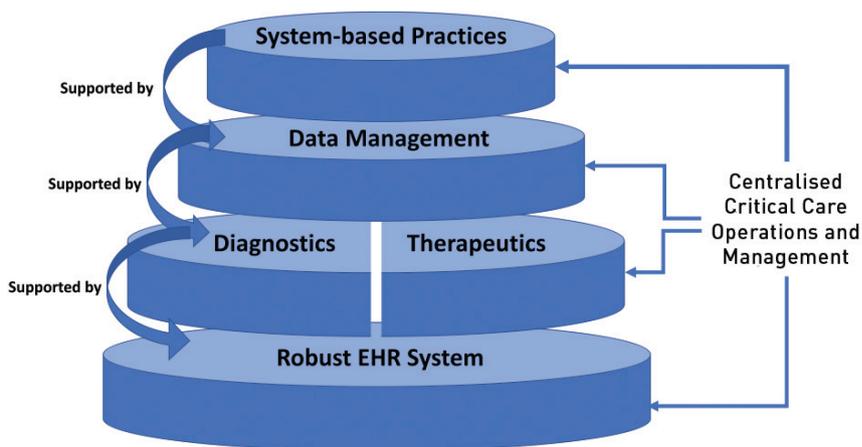


Figure 1. A proposed framework for comprehensive management of influenza. In the proposed framework, system-based practices are implemented based on accurate data collection and analysis, which is more feasible with consistent diagnostic and therapeutic practices. A robust EHR can facilitate the standardisation of both diagnostics and therapy. All aspects are effectively managed via a centralised critical care operations effort.

Diagnostics

Uncoordinated or inappropriate diagnostic efforts can lead to excess costs to the system and potential harm to the patient in the form of inappropriate treatment or expense. Uninformative tests, such as the enzyme-linked immunosorbent assay (ELISA), are no longer recommended according to the most recent Infectious Disease Society of America (IDSA) guidelines, but still widely used (Uyeki et al. 2018). Moreover, multiple platforms and modalities, as are common in many large health systems, can lead to excessive or duplicate tests. In an analysis of influenza (2017 season) patients from one hospital within the authors' health system, of those that received a respiratory viral panel (RVP) polymerase chain reaction (PCR) test for the diagnosis of influenza, 43% were tested by an ELISA rapid influenza test that preceded it (unpublished data). Current guidelines recommend PCR as the diagnostic modality

respiratory viral culture or expanded PCR and procalcitonin) and a robust, centrally coordinated education and outreach effort. Diagnostic options and their associated costs should be evaluated at the system level in order to identify the most informative test(s) at the lowest cost. For example, the procalcitonin test may be included in the influenza diagnostic algorithm to assist in delineating viral from bacterial infection (Muller et al. 2007). Finally, standardisation throughout the EHR, including elimination of misleading or duplicative testing options, is integral to success.

Treatment

While treatment of influenza is largely supportive, the use of antiviral therapy has been shown to reduce severity and duration of illness in patients infected with the virus (Dobson et al. 2015). According to current IDSA guidelines, antiviral therapy is recommended for any patient with

influenza severe enough to be hospitalised, has severe, complicated, or progressive illness; or is at higher risk for influenza complications (Uyeki et al. 2018). Risk factors for complicated or severe disease are indicated in **Table 1**. Antiviral treatment with neuraminidase inhibitor therapy is recommended as early as possible for any patient with confirmed or suspected influenza. Despite this, antiviral therapy is not universally used for seasonal influenza outbreaks (Kramer and Bansal 2015).

Table 1: Risk Factors for Influenza Complications.

- Children younger than 2 years
- Adults 65 years and older
- Chronic pulmonary (including asthma), cardiovascular (except hypertension alone), renal, hepatic, haematological (including sickle cell disease), and metabolic disorders (including diabetes mellitus), or neurologic and neurodevelopment conditions
- Immunosuppression, whether caused by medications or by HIV
- Women who are pregnant or postpartum (within 2 weeks after delivery)
- Younger than 19 years who are receiving long-term aspirin therapy
- American Indians/Alaska Natives
- Extremely obese (BMI >40)
- Residents of nursing homes and other chronic care facilities

Source: Adopted from the Centers for Disease Control and Prevention (CDC).

Any comprehensive influenza management programme should include the elucidation of a standardised treatment algorithm backed by a robust, centrally coordinated education and outreach effort. This algorithm should include any different options for antiviral therapy. A typical default treatment option may include oseltamivir, which has been shown to

be effective against both influenza A and B, and comes in an oral as well as elixir form, and alternative treatment options, with associated restrictions, may include peramivir, which is intravenous and can be used in patients with at-risk airways, requiring non-invasive positive pressure ventilation, or without enteral access. As with diagnostic efforts, standardisation throughout the HER (including elimination of duplicative or misleading treatment options) is integral to success.

Data collection

A cohesive data collection and reporting system is essential for successful understanding of the impact of influenza on a health system. Inadequate efforts can lead to financial, time and resource inefficiencies (Chen et al. 2015). As a precondition to data integrity, a standardised diagnostic algorithm is crucial for the capture of all relevant encounters, especially when different workflow processes cause difficulty in comparing data from one site within a health system to another (Blijleven et al. 2017). Data collection and dissemination should be part of a centralised effort, which includes interaction with local and system laboratory personnel, recognition of diagnostic pathways (including the possibility of secondary or duplicative testing), and the leveraging of a robust EHR in order to track patient disposition. At a minimum, efforts should include a data warehouse query of any encounters where influenza is considered, compiled at the aggregate level, and a periodic reporting of positive/negative flu cases throughout the system. An example is included as **Figure 2**. A more insightful effort may include creation of an influenza dashboard, which would show, in real time, the locations and status of the patients currently being treated for influenza interposed upon local and national influenza data.

The accurate collection of patient encounter data may provide the backbone for future efforts in the development of predictive

algorithms. Efforts at the predictive modeling of influenza have shown recent promise but have not been robustly studied at the health system level (Morris et al. 2018). However, with enhanced and improved data collection, this may be possible in the not too distant future. One of the major obstacles in dealing with seasonal influenza is the ability to predict the onset and severity of the season as well as the need for ICU resources (Hick et al. 2010). A better ability to forecast may lead to improved planning for diversion and bed management (Zhang et al. 2006). At the critical care level, where resources are especially scarce and costly, such predictive efforts would be extremely valuable.

System-based practices

System-based practices focus on the broader context of patient care within the multiple layers of a healthcare system (acgme.org). Such efforts should lead to improved patient outcomes while simultaneously minimising waste, and inefficiency. Standard of care influenza related system-based practices include prevention strategies via vaccination, visitation restrictions, and isolation precautions. Additional efforts include patient or employee cohorting as well as creative staffing options in the event of employee illness.

Cohorting may provide an additional level of system-based infection prevention, but this practice remains controversial. The practice involves co-location of patients with a known common pathogen, thus minimising spread of infection by virtue of geographic separation. Evidence for cohorting is relatively limited to a few studies, a couple of which include influenza (Pelat et al. 2016; Islam et al. 2013; Youngs et al. 2019; Ong et al. 2001). While patient monitoring may be easier and there may be economies of scale in the supply chain for isolation equipment, patient movement and relocation may cause a transient loss of bed space and may be disruptive to both patients and care providers. Employee

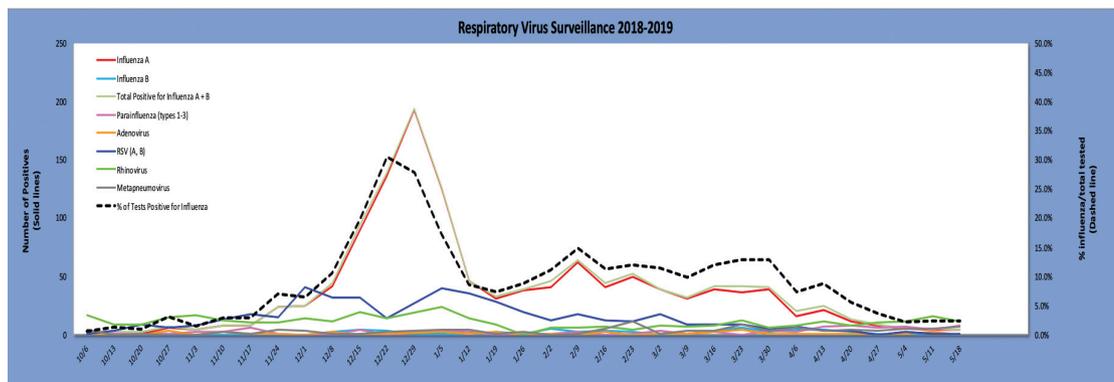


Figure 2. An example of a data warehouse report regarding respiratory viral infection at one large U.S. health system. Such reports can be updated and disseminated on a weekly basis, such as this one. A more advanced report may consist of delineation of patient disposition (admitted versus discharged from the ED) as well as inpatient location (ICU versus medical ward).

cohorting, or the delineation of defined health care workers assigned to care for influenza patients, may minimise the risk of excessive employee call-outs due to illness (Palmore and Henderson 2013).

Staffing remains the single most vulnerable resource in general in critical care, and risks are amplified in the event of a surge in illness during seasonal influenza (Holdorf and Lilly 2015). Notably, a critical care bed shortage can be a significant obstacle during influenza season, but is a static limitation, not subject to change from season to season. In fact, critical care capacity strain is often obviated in the context of staffing shortages (Bagshaw et al. 2017). Staffing crises during influenza outbreaks are well described (Fowler et al. 2003). Centrally directed and managed creative staffing options may provide a buffer in the event of employee illness and borrows from disaster preparedness models (Daugherty et al. 2007). These considerations include the deployment of flexible or shared coverage plans, the utilisation of advanced practice

providers (APPs) and attending physicians across neighbouring units within a hospital, and the assistance and support of a robust electronic ICU (eICU). The standardisation of the critical care work week across a health system may help to alleviate the difficulty in coordinating emergency coverage amongst intensivists from different ICUs with variable start days and duration of service.

Conclusion: A Comprehensive Approach

Successful preparation for the eventuality of an influenza outbreak is contingent upon proper protocols and infrastructure, such that patient and staff safety are ensured and that there is benefit to the patient (Gomersall et al. 2007). Standardisation of processes, including diagnostic and treatment protocols, are essential for the adequate collection of data regarding influenza. Succinct and meaningful acquisition and dissemination of data (including predictive efforts) allow for the comprehensive understanding of the impact of influenza on a system in

general, and a critical care department in particular. Such an understanding will allow for efficient and cost-effective utilisation of resources. ■

Key Points

- Influenza remains a significant global health burden, with the number of deaths estimated to be 300,000-600,000 per year, and the number of hospitalisations estimated at 3-5 million.
- Though the percentage of patients diagnosed with influenza needing ICU admission remains small, there is still a sizeable impact on intensive care resources at many hospitals.
- Rarely is influenza managed in a cohesive way within a health system, and levels of preparedness for outbreaks are poor.
- Uncoordinated or inappropriate diagnostic efforts can lead to excess costs to the system and potential harm to the patient in the form of inappropriate treatment or expense.
- A standardised approach at the system level, using one universally accepted diagnostic algorithm, is essential for the elimination of waste and to assist in data tracking.
- The accurate collection of patient encounter data may provide the backbone for future efforts in the development of predictive algorithms.

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