Use of a new patient-dedicated blood gas analyser could aid transmission control and enhance workflow in intensive care units, particularly when under pressure during outbreaks of winter influenza

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**Seasonal influenza (flu) is an unpredictable but recurring pressure that hospitals face every winter. Each year, approximately 10% of Europe’s population is infected, with flu-related complications resulting in hundreds of thousands of hospitalisations across Europe. Indeed, reports from week 40/2015 (the start of weekly reporting on influenza activity in the WHO European Region) through to week 07/2016, document that over 70,000 flu detections were reported throughout the region during that period.**

Most patients with uncomplicated flu infection do not require hospital referral. However, patients who might require hospital admission fall into two main groups: those with worsening of a pre-existing medical condition, such as chronic respiratory or cardiac conditions, and those with an influenza-related complication such as influenza-based pneumonia, which can be life-threatening especially in older people and younger children. Consequently, flu is a common cause of admission to the intensive care unit (ICU) during the flu season – normally only around 1% of flu cases require hospitalisation. However, of these 10–30% may require admission to the ICU, depending on their general indications which will include persisting hypoxia, progressive hypercapnia, severe acidosis and septic shock.

The burden of admissions during flu epidemics is therefore a significant one. For example, last year in Lower Saxony (Germany), some clinics had to accommodate their patients in hallways due to pressures caused by a flu outbreak. To reduce the impact of flu infection and admission rates, flu vaccine is the most effective means. However, the efficacy of flu vaccination varies across patient groups related to both age and immune competency, and depends on a match with the circulating virus of the season. There is also still a matter of prediction of the likely prevalent circulating strain, which does not always work out. Furthermore, the disease is constantly mutating, with the emergence of new strains, which can lead to pandemics.

**Economic burden**
Seasonal influenza imposes a substantial economic burden on hospitals, in the form of treatment costs, disruption to elective treatments and lost productivity.

**Costs of hospitalisation**
A recent study demonstrated that seasonal flu, even at a time of low overall activity, is associated with a substantial burden of illness. The UK study recorded 156,193 influenza episodes between January 2001 and March 2009. From these, 1592 (only 1%) were hospitalised with a mean length of stay of seven days.

Costs were analysed for these episodes and confirmed that they do escalate with complicated influenza episodes (average cost influenza £2264/hospitalisation versus complicated influenza £9384/hospitalisation) and age (<64 years £6166/hospitalisation; ≥65 years £11,674/hospitalisation).
Furthermore, respiratory and chronic heart disease risk status had the highest overall costs, but central nervous system risk had the highest cost per episode (£15,198/hospitalisation).

Cancelled operations
The overall burden of flu in each season on critical care bed occupancy will also have an important impact on the number of cancelled operations. Cancelled operations are a waste of resources and time, bringing the additional administrative burden of re-scheduling appointments or a blank theatre slot. For example, in 2001 it took an average of nine months for the UK’s NHS to work through the backlog of elective work created by a three-week period of cancellations during the winter of 2000. The cost of not putting in additional bed capacity during three weeks in January and February 2000 has been calculated to be in excess of £750 million.6

Staff shortages
Another economic impact of flu in hospitals is related to frontline healthcare workers themselves. Since they are more likely to be exposed to the influenza virus, particularly during winter months when some of the people in their care will be infected, it is vital to reduce the impact of flu and the strains of personnel shortage to protect patient care. Indeed, it has been estimated that up to 1 in 4 healthcare workers may become infected with influenza during a mild influenza season; this is a far higher incidence than expected in the general population. Furthermore, the patient population in a hospital will also be particularly vulnerable to flu infection with potentially severe effects. Notably, during an influenza outbreak in one UK NHS Trust, at one stage 118 staff and 49 patients were infected.7

In recognition of the pressures caused by flu epidemics, many Governments are injecting additional money into their respective healthcare systems. For example, last winter (2014–2015) £700 million was injected to support the NHS in the UK. The local NHS states that this has helped bolster the service with an extra 700 doctors, 4500 nurses and more than 3000 extra other staff, whilst also creating over 5000 more beds.8

Organisational burden in the ICU
Seasonal influenza can also place a substantial organisational burden on the ICU, which in the case of a full blown epidemic can become overwhelming. For example, recent data showed that around 20% of ICU bed capacity was taken up in Scotland at the peak of the 2010/11 season and nearly 10% in 2012/3 and 2013/4.9 Menon et al. modelled the effect of a full pandemic and found that under most conditions, more than 100% of the ICU bed and ventilator capacity would be required for treatment of acute respiratory failure patients.10

In addition to the pressure on bed and ventilator capacity, influenza patients place significant burdens on staffing and staff activities. Through the transmissible phase of the disease they require increased infection control measures, ideally isolation. Isolation beds or single-room isolation can play a key role in preventing contact and droplet-spread between vulnerable patients. Furthermore, the nature of acute respiratory failure and potential onset of sepsis and other complications means that they are a patient group with a relatively high dependency of care, at a time when staff shortages are most likely. Consequently opportunities for enhancing workflow should also be considered to support stretched nursing staff.

Efficient ICU blood gas analysis
Blood gas measurements are important parameters when monitoring critical care patients with respiratory complications. Since frequent arterial blood sampling is necessary, a key aspect of infection prevention and control with such patients will therefore be the management of their blood samples, particularly during collection and transportation for analysis. Furthermore, any draw of arterial blood requires stringent infection control techniques to avoid the possible introduction of a blood stream infection, which is associated with high mortality rates and costs of care, as well as avoiding blood-splash injury to caregivers.

A new blood gas monitoring system that addresses these issues, and also those around the organisational burden in the ICU imposed by flu outbreaks has recently been developed by Sphere Medical (Cambridge UK) (Figure 1). Uniquely, the Proxima miniaturised in-line analyser enables the rapid and frequent delivery of blood gas results directly at a patient’s bedside without the need for the caregiver to walk away to a central analyser. This is not only ideal from an infection control perspective, but also from a workflow perspective, since it has the potential to reduce the amount of time spent away from the patient enabling frequent sampling.

**Fig. 2:** Blood is withdrawn directly into the in-line Proxima Sensor for blood gas analysis, minimising the number of openings of the arterial line for sampling. All blood sampled is returned to the patient ensuring no blood loss and enabling frequent sampling.
perspective, but this then aids workflow improvements for testing, as well as early decision-making to ensure closer control of therapy and enhance patient outcomes.

Maintaining isolation and reducing blood handling
As previously discussed, infection and transmission control precautions are essential to minimise the burden of infection outbreaks on ICUs. Operating as a closed system with an in-line design, the patient-dedicated Proxima arterial blood gas monitoring system keeps infection control simple and effective, and reduces transport of people and samples around the unit as a vector for transmission of infection.

Blood is withdrawn directly into the in-line Proxima Sensor for analysis, minimising the number of openings of the arterial line for sampling (Figure 2). This protects both the patient’s blood from exposure to bloodstream infections, and also the caregiver by limiting exposure to blood borne pathogens during the course of routine patient care.

Since it avoids the transfer of blood to a central blood gas analyser, Proxima also reduces blood handling and therefore cuts risk of infection transmission. Blood samples from isolation patients are kept within the isolated area and the caregiver by the patient’s bedside as a further infection control measure. Additionally, the Proxima closed sampler returns all blood safely to the patient which avoids the need for waste management of potentially infected blood specimens and syringes.

Workflow improvements for testing
Proxima can also help to reduce nursing dependency of the patient and enhance workflows during blood gas analysis. This is because results are rapidly returned directly to the patient’s bedside monitor within three minutes without the additional step of the caregiver walking away for analysis, saving significant time. Furthermore, there is no need for an additional nurse to be found to monitor a critically ill patient while central blood gas measurements are made. This in turn delivers opportunities for enhancing workflow to support nursing staff stretched due to staff shortages caused...
by illness. During influenza pandemic, it has been estimated that staff illness could reach 25% with work absences of 5–8 days. 10

Enhancing blood gas infrastructure resilience

An additional consideration is that during flu epidemics the actual blood testing infrastructure will also be under extreme pressure. Since Proxima is patient-dedicated, this will spread blood gas testing across multiple systems rather than it being concentrated on just a few central analysers that can become a pinch point.

Close clinical management

Patients who present initially with uncomplicated influenza may rapidly progress (within 24 hours) to more severe disease and complications. Therefore, they will require close observation and rapid interventions. These critically ill patients include those who experienced rapidly progressive lower respiratory tract disease, respiratory failure, and acute respiratory distress syndrome (ARDS) with refractory hypoxemia.

Initial management of patients with influenza-related respiratory complications in the ICU can include provision of oxygen therapy in hypoxic patients with monitoring of oxygen saturation and inspired oxygen concentration with the aim of maintaining PaO₂ ≥8kPa and SaO₂ ≥92%. Oxygen therapy in patients with pre-existing COPD complicated by ventilator failure should also be guided by repeated arterial blood gas measurements, with the aim of keeping SaO₂ >90% without causing a fall in arterial pH below 7.35. 11

In addition, patients with influenza A (H1N1) virus who require mechanical ventilation have the potential to rapidly deteriorate and develop refractory hypoxemia necessitating use of salvage therapies, that is, prone positioning, high-frequency ventilation and ECMO. 12

Since frequent arterial blood sampling is essential for the close clinical management of these patients, the patient-dedicated Proxima arterial blood gas monitoring system is again ideal as it allows rapid and frequent measurements to be made. As previously discussed, blood is withdrawn from the patient directly into the Proxima Sensor for analysis and results then displayed on a bedside monitor. By measuring parameters in the patient’s bed space, as opposed to taking a sample and then walking away from the patient for analysis at a central analyser, this enables timely interventions and closer clinical management (Figure 3).

Furthermore, as Proxima is a closed system which ensures that all blood sampled from the arterial line is returned directly to the patient, carers can take as many arterial blood gas measurements as necessary without risk of complications associated with iatrogenic blood loss.

Conclusion

Frequent measurement of arterial blood samples is a key component in the effective clinical management of patients in the critical care environment, particularly those that are unstable and with flu-related respiratory complications. Rapid return of data and swift response to changing blood gases is as essential in critical patient care as the continual measurement of blood pressure. Therefore, fast feedback and response via an in-line miniature blood gas analyser such as Proxima at the patient’s bedside could have a real impact on efficiently stabilising patients and saving time in an ICU unit pressurised by staff shortages.

Furthermore, as a patient-dedicated analyser, Proxima can offer real infection prevention and control benefits for the blood gas analysis of patients in ICU isolation beds. Such benefits could be particularly important during outbreaks of readily transmissible infections, such as winter influenza, which is a common cause of admission to the ICU.

For further information about the Proxima patient-dedicated blood gas analyser, please visit: www.spheremedical.com/products/proxima.

References

1. European Centre for Disease Prevention and Control. Influenza virus characterisation, summary


