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How is My Patient Doing? Evaluating Hospitalized Patients Using Continuous Vital Signs Monitoring

Eyal Zimlichman MD[1]*, Martine Szyper-Kravitz MD[1], Avraham Unterman MD[1], Anny Goldman RN[1], Shiraz Levkovich[2] and Yehuda Shoenfeld MD[1]*

[1]Department of Medicine B, Sheba Medical Center, Tel Hashomer, and Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel.
[2]EarlySense, LTD, Ramat Gan, Israel

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The value of assessing basic vital signs, such as heart rate and respiration rate, in hospitalized patients and specifically in patients with respiratory distress is well documented and constitutes one of the basic foundations of clinical medicine. However, monitoring of vital signs in patients hospitalized not in the intensive care unit is usually limited to occasional assessment and documentation, usually several hours apart. Since both heart rate and respiration rate are essential for assessing clinical status specifically in patients with hemodynamic and/or respiratory decompensation, we assume that continuous monitoring of HR and RR will provide the clinician with a valuable tool.

Recently, a novel device for continuous monitoring of HR, RR and agitation level (indicated by measuring movement in bed) has been introduced. The Everon™ monitor (Earlysense LTD.) is a non-contact sensitive mechanical sensor that is placed under the patient's mattress and measures respiration, heart rate and crude bed movements with continuous recording and display on a bedside monitor (FDA approval K070375, 5 November 2007). A prior study comparing the Everon to reference gold standard devices found its accuracy to be over 90% in both respiration and heart rate [1]. The monitor was designed to activate an alarm in the event of clinical decompensation as well as provide continuous clinical data to help the clinician better estimate the clinical picture. This monitoring system was put to use in our internal medicine department as a non-interventional pilot study, specifically for patients hospitalized with pneumonia, exacerbation of chronic obstructive lung disease or congestive heart failure. Data from the monitoring system were analyzed retrospectively and compared to the patient's chart. We describe here a patient hospitalized with exacerbation of COPD who was monitored by the Everon, focusing on the potential application of continuous vital signs monitoring.

HR = heart rate
RR = respiration rate

***Dr. Zimlichman and Prof. Shoenfeld both provide professional counseling to EarlySense LTD.**

PATIENT DESCRIPTION

A 61 year old man with ulcerative colitis not treated medically complained of 3 days of productive cough, fever, dyspnea and pleuritic chest pain. On admission to the emergency department he was mildly tachypneic with 24 breaths/min and room air saturation of 95%. Physical examination revealed decreased breath sounds in the right lung with egophany on the right, while chest radiography displayed a right upper lobe infiltrate.

Blood laboratory results demonstrated a slightly elevated leukocyte count (12,500/μl), mild renal impairment with creatinine of 1.6 mg/dl and urea 67 mg/dl, and hyponatremia 130 mEq. The patient was admitted to our department with the diagnosis of right upper lobe pneumonia. On his admission, Pneumonia Patient Outcomes Research Team score was 134 (PORT class V). He was started on intravenous ceftriaxone and oral clarithromycin. On the second day of hospitalization his dyspnea worsened, his sputum became streaked with blood and his room air saturation decreased to 89%. Blood count showed a sharp rise in leukocytes (21,000/μl) and a second chest film revealed a worsening of the right infiltrate. Blood cultures and sputum cultures were positive for group A streptoccocal bacteria. Acid-fast stain of sputum revealed no acid-fast bacilli. On the following day, a sharp deterioration in his respiratory status was noted as the patient was found with severe tachypnea of 35–40 breaths/min while saturation on oxygen mask was 85%. The patient was intubated and connected to a respirator machine. Chest computed tomography revealed consolidations in the right upper and middle lobes with several abscesses in the right upper lobe and right pleural effusion. The patient was then transferred to the ICU with the working diagnosis of necrotizing pneumonia.

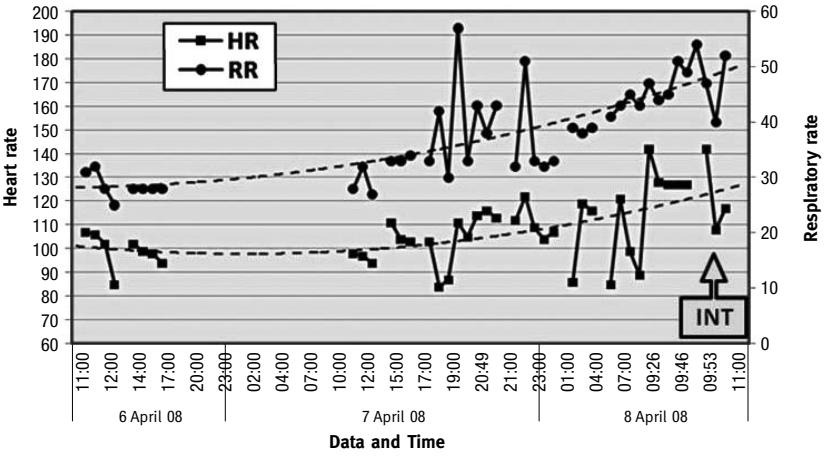
COPD = chronic obstructive lung disease

PORT = Pneumonia Patient Outcomes Research Team
ICU = intensive care unit

During his stay in the ICU several chest tubes were inserted with continuous drainage of empyema fluid and abscess drainage. The patient was treated with intravenous penicillin G therapy according to the Streptococcus susceptibility. Following a 12 day stay in the ICU, and after the patient was extubated, he was transferred again to our department for continuing therapy and observation. He completed a 14 day antibiotic treatment, underwent respiratory physiotherapy and received nutritional support. His clinical condition was stable and he was discharged home after a further 8 days in the hospital.

While in our department the patient was monitored by the contact-less EverOn™ monitor as part of a non-interventional study conducted in our department. A continuous reading of respiration and heart rate is displayed in the Figure.

Figure 1. Patient's respiration and heart rate over the course of the hospitalization



INT = time of endotracheal intubation and subsequent transfer to the ICU, HR = heart rate, RR = respiration rate.

Missing data represent time when the patient was out of bed and recording could not be performed.

COMMENT

Most hospitalized patients are at low to average risk for immediate mortality and are placed in a non-ICU setting. These patients might decompensate clinically, either from worsening of their primary disease for which they were hospitalized or due to a complication related to the hospitalization (i.e., nosocomial infections, thromboembolic event, adverse drug reaction, etc.). To compound the situation, patients in the general wards of hospitals are becoming more acutely ill and there is no accompanying relative growth in staff resources or ICU beds. Early identification of these patients is clinically important since delay in diagnosis and triage is associated with marked increases in mortality. Some groups have documented a 30% increase in absolute mortality when the transfer of decompensating ward patients to the ICU is delayed [2]. In 2003, Kaboli and Rosenthal [3] termed ICU transfer delay a "preventable adverse event" that "must be addressed." Furthermore, researchers found that most cardiac arrests, deaths and emergency unplanned intensive care admissions are preceded by antecedents (mostly hemodynamic) that, if identified, might lead to an earlier response by health teams [4]. Recently, a great deal of attention has focused on these patients – in the form of "rapid response teams." These are teams that are called for a prespecified set of physiological abnormalities, symptoms, or signs. Current observational data suggest that rapid response teams might decrease mortality in these patients and advocated the implementation of RRT in U.S. acute care hospitals. This was endorsed by the JCAHO (Joint Commission on Accreditation of Healthcare Organizations), which recently proposed a 2008 National Patient Safety Goal related to RRT [5].

However, such interventions require that apparently low risk patients be monitored in the wards continuously to allow for immediate detection of decompenstaion. We present here our experience with such a system, which was designed specifically for patients in hospital wards. On retrospective analysis of the Everon™ data collected from our pneumonia patient, we noticed the sharp increase in respiration rate and heart rate during the first 3 days of hospitalization. The patient's RR increased from around 30/min to 50/min, while his HR increased from 100/min to 130/min within a span of 2 days. This deterioration was indicative of the atypical course of this pneumonia case, which eventually led to intubation and transfer to the ICU. Furthermore, specific events of high respiration rate were documented 12 hours prior to intubation, which might have predicted the following day's respiratory failure and transfer to the ICU. We believe that in this case, the Everon™ data, as displayed here, provided an accurate assessment with high correlation to the patient's clinical status.

While most patients treated for pneumonia in the hospital respond to antibiotic and supportive therapy, some do not respond as expected and require that the clinician consider additional evaluation and modification of treatment. In order to better assess the patient's clinical status, continuous monitoring of data such as fever, RR, HR and oxygen saturation; laboratory data such as arterial blood gases and leukocyte count;

RRT = rapid response team

and follow-up chest imaging, together with the patient's subjective assessment, must be available to the clinician so that he or she can identify any deterioration and make appropriate clinical decisions. As continuous monitoring of vital signs record early changes and display shifts towards unfavorable outcomes, like respiratory distress, it can become an important tool for earlier intervention and prediction of the patient's clinical deterioration.

In conclusion, from this descriptive case, we suggest that continuous monitoring of RR and HR for patients hospitalized in a non-ICU setting can provide valuable information to the clinician both as an early warning for decompensation and to allow better decisions based on clinical data. Further experience with this tool is needed, including interventional studies aimed at measuring outcomes, before its true advantages can be claimed.

Correspondence:
Dr. E. Zimlichman
Dept. of Medicine B, Sheba Medical Center, Tel Hashomer 52621, Israel
Phone: (972-3) 530-2661
Fax: (972-3) 535-2855
email: zimliche@post.tau.ac.il

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