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Improving the work efficiency of healthcare-associated infection surveillance using electronic medical records

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ABSTRACT

In this study, we developed an integrated hospital-associated urinary tract infection (HAUTI) surveillance information system (called iHAUTISIS) based on existing electronic medical records (EMR) systems for improving the work efficiency of infection control professionals (ICPs) in a 730-bed, tertiary-care teaching hospital in Taiwan. The iHAUTISIS can automatically collect data relevant to HAUTI surveillance from the different EMR systems, and provides a visualization dashboard that helps ICPs make better surveillance plans and facilitates their surveillance work. In order to measure the system performance, we also created a generic model for comparing the ICPs' work efficiency when using existing electronic culture-based surveillance information system (eCBSIS) and iHAUTISIS, respectively. This model can demonstrate a patient's state (unsuspected, suspected, and confirmed) and corresponding time spent on surveillance tasks performed by ICPs for the patient in that state. The study results showed that the iHAUTISIS performed better than the eCBSIS in terms of ICPs' time cost. It reduced the time by 73.27 s, when using iHAUTISIS (114.26 s) and eCBSIS (187.53 s), for each patient on average. With increased adoption of EMR systems, the development of the integrated HAI surveillance information systems would be more and more cost-effective. Moreover, the iHAUTISIS adopted web-based technology that enables ICPs to online access patient's surveillance information using laptops or mobile devices. Therefore, our system can further facilitate the HAI surveillance and reduce ICPs' surveillance workloads.

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1. Introduction

Healthcare-associated infections (HAIs) are infections that patients acquire during the course of receiving treatment for other conditions within a healthcare setting [1]. Mostly, HAIs only appear in patients hospitalized for 48 h or longer (refer to the 48 h criterion). It estimates that approximately 1.7 million HAIs occur in hospitals, and 99,000 associated deaths occur each year in the US [2]. According to World Health Organization report, HAIs are major worldwide causes of death and disability [3,4]. Thus, HAIs are critical patient safety and healthcare quality issues [5]. Prevention and reduction of such infection has become one of the top priorities for health care.

The US Centers for Disease Control (CDC) has published guidelines to define HAI and surveillance criteria for specific types of HAI in acute care settings [6–8]. One of the most effective approaches to prevention and reducing HAIs is intensive surveillance that detects changes in clinical signs that require frequent, repeated and detailed bedside assessment on a patient by patient basis [7,9]. It is time-consuming, labor-intensive, and expensive to implement [10]. Most hospitals cannot afford to conduct such comprehensive surveillance activities. Based on the CDC's case definitions of healthcare-associated urinary tract infection (HAUTI) [8], the criteria involve the use of combination of signs, symptoms, and laboratory findings. Thus, making a firm diagnosis of HAUTI was not always straightforward because of the inconsistent relationship between symptoms, pyuria, and bacteriuria [11–13]. Therefore, infection control professionals (ICPs) spend most of time on patient data collection, suspected cases finding, medical records review, bedside investigation, and so on. They can hardly free up their valuable time for proactive preventive activities that may reduce HAIs [14–16].

The electronic medical records (EMR) are records about patient care that can be processed by a computer [17,18]. With increased adoption of EMR systems in recent years [10,14,19], more and more sophisticated HAI surveillance data are made available in the electronic medical records. Thus, hospital-wide surveillance data on HAIs can be collected in a cost-effective way. There have been computerized HAI surveillance information systems (HAISISs) that rely on culture-based information systems [20–23], or on predictive models to improve infection control and disease surveillance [24–26]. Although the electronic culture-based surveillance systems can help ICPs saving their time in HAI surveillance work as well as for case management (e.g. follow-up of isolation procedures), there lacks a formal model for measuring the work efficiency between different types of electronic surveillance systems. Our aims were to develop an integrated HAI surveillance information system based on existing EMR systems for improving the work efficiency of ICPs, and create a generic model as a common platform for comparing ICPs' work efficiency when using different electronic HAISISs. In this paper, we focused on HAUTI to illustrate the settings and methods for evaluating the work efficiency of two different types of electronic HAUTI surveillance systems.

2. A generic work model for HAI surveillance

HAI surveillance involves active case-finding by infection control teams and clinicians, uses clinical case definitions, and requires the collection of additional data to determine the infection source. ICPs need to routinely collect patients' clinical data and laboratory tests results, and then analyze the data based on the CDC's guidelines to determine whether the patients are HAI cases. In general, patients may have experienced three states from the time of hospital admission to the time of hospital discharge: unsuspected, suspected, and confirmed. Thus, we can use a state transition diagram to model the workflow of HAI surveillance (Fig. 1) [27]. A circle represents a patient state, and the arrow that connects two states represents a transition from one state to another, i.e., from the state at the tail end of the arrow to the state at the arrow head end. Each state may be associated with a group of patients whose states are the same as that state, and a set of surveillance tasks that should be performed to the patients with that state. The performance of the HAI surveillance tasks on an individual patient may lead to trigger the patient's state change. The trigger is labeled on the edge between a "from state" and a "to state".

Patients admitted to a hospital are supposed to be non-HAI cases. They are assigned to "unsuspected" state. For a patient in "unsuspected" state, ICPs collect and analyze his/her data relevant to HAI. If the patient's conditions are likely to meet the HAI case definitions, and meet the 48 h criterion, then he/she

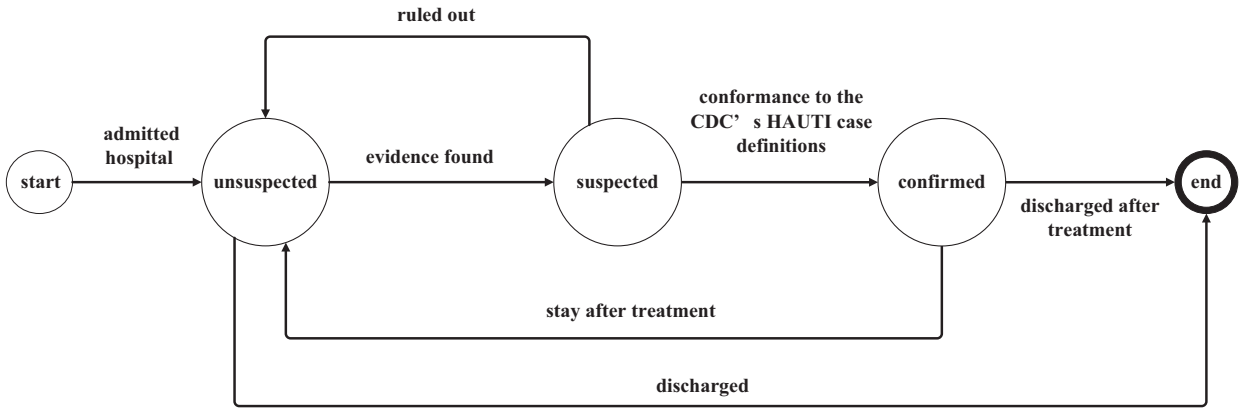

Fig. 1 – A patient's state transition diagram.