A Scoring System for Identifying Severe Cases of Influenza-like Illness by Comorbidity and Age -- A Nationwide Cohort Analysis

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Background

Influenza-like illness (ILI) is often the first presentation to clinicians in daily clinical practice. With limited healthcare resources and finite medical attention, how to identify high-risk ILI cases by considering the underlying comorbidity attributes becomes an important issue for appropriate case management at clinical frontline.

Materials and Methods

Retrieved from the one-million-per-year systematic sampling patients of Taiwanese National Health Insurance Database from 2008 to 2010, our cohort composed of all inpatient encounters (admissions) with the diagnostic ICD-9 (International Classification of Diseases, Ninth Revision) that matched the ILI definition proposed by Marsden-Haug's Code-based Syndromic Surveillance in the defined scenarios. The defined scenarios were: within the same hospitalization, or with a prior ambulatory visit (outpatient clinic or emergency room) one or two days earlier. Comorbidity attributes were defined by appropriate ICD-9 codes that included most chronic diseases in several categories: immune-related, pulmonary, metabolic, cardiovascular, and others. Four outcome measures represented severe ILI cases: hospitalization cost, length of stay (LOS), death, and intensive care unit (ICU) entry.

Univariate and multivariate analyses were done with the dependent variables as worse outcome, and the comorbidity attributes as covariates with the adjustment for gender in pre-defined age strata. The selected comorbidity attributes formulated Comorbidity vector and the corresponding age strata formulated Age vector. Comorbidity score was defined as the dot product of Comorbidity vector and Age vector. Its performance was assessed by Spearman correlation and by receiver operating characteristic (ROC) curves.

Results

Our cohort had 319,775 ILI inpatient cases, of which 8.82% entered ICU and 3.83% died at hospital discharge. The significant comorbidity attributes varied in each age stratum: congenital anomaly and heart failure in the age from 0 to 5 years; congenital anomaly, cancer, heart failure, non-dialyzed renal insufficiency, and transplant in the age from 6 to 17 years; cancer, diabetes, heart failure, stroke, chronic obstructive pulmonary disease (COPD), liver cirrhosis, non-dialyzed renal insufficiency, and human immunodeficiency virus (HIV) in the age from 18 to 44 years; heart failure, stroke, and non-dialyzed renal insufficiency in the age from 45 to 64 years; heart failure, COPD, and non-dialyzed renal insufficiency in the age from 65 to 74 years; tuberculosis, heart failure, and non-dialyzed renal insufficiency in the age from 75 years and above.

Comorbidity vector was (**heart failure, non-dialyzed renal insufficiency, cancer, tuberculosis, stroke, congenital anomaly, transplant, HIV**). Age vector was (1, 1, 6<=age<45, 75<=age, 18<=age<65, 0<age<=18, 6<=age<18, 18<=age<45). Comorbidity score, the dot product of comorbidity vector and age vector, showed significant correlation with hospitalization cost (Spearman rho=0.1885, p<0.0001), and with LOS (Spearman rho=0.1717, p<0.0001). Its ROC area-under-curves (AUC) were 0.7454 with death and 0.6840 with ICU.

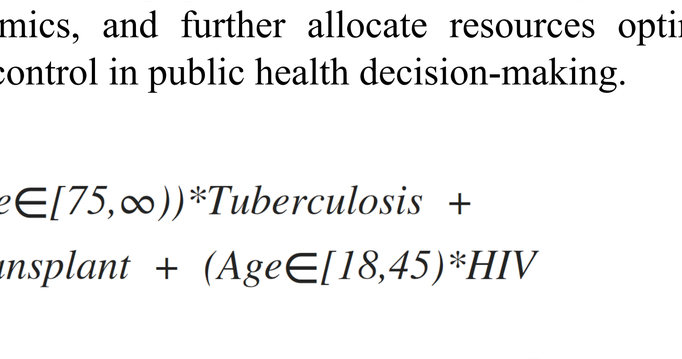
Conclusions

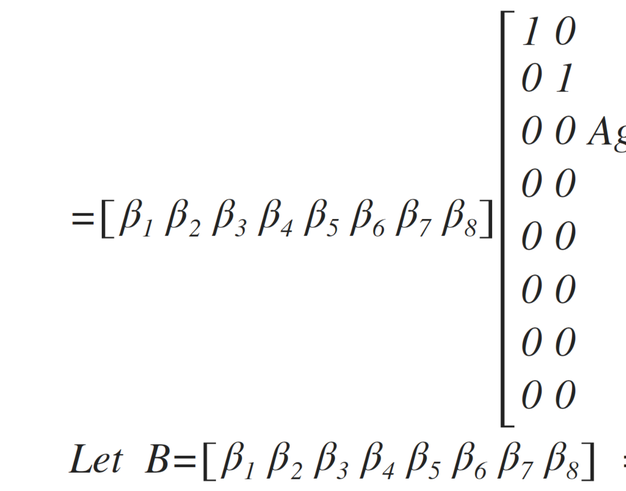
Higher clinical alertness should be set once an ILI case matches the following attributes: heart failure in any age, non-dialyzed renal insufficiency in any age, cancer in school-age children up to mid-age adults, tuberculosis in the elderly, stroke in adults, congenital anomaly in children and adolescents, transplant in school-age up to adolescents, or HIV in young adults. The risk estimation would facilitate us to address population measures for upcoming severe influenza epidemics, and further allocate resources optimally for prevention and control in public health decision-making.

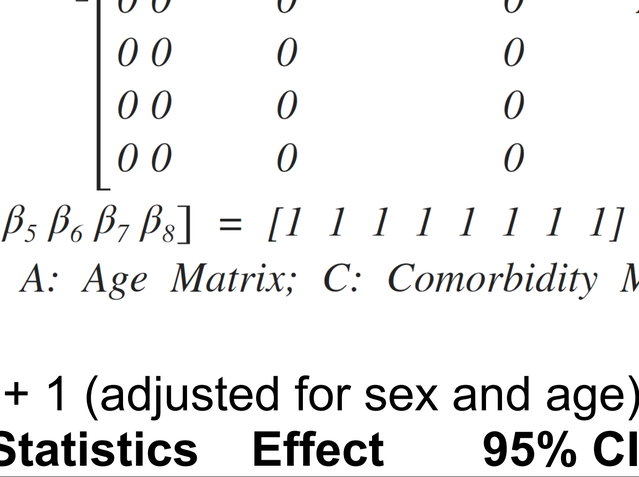
$$
\begin{aligned}
&ILI\ \ Sverity\ \ Score \\
&= 1*(Heart\ \ failure) + 1*(Renal\ \ insuff.) + (Age\in[6,45))*Cancer + (Age\in[75,\infty))*Tuberculosis + \\
&\quad (Age\in[18,65))*Stroke + (Age\in(0,18))*Congenital + (Age\in[6,18))*Transplant + (Age\in[18,45)*HIV \\
&= B\cdot A\cdot C \\
&=[\beta_1\ \beta_2\ \beta_3\ \beta_4\ \beta_5\ \beta_6\ \beta_7\ \beta_8]
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & Age\in[6,45) & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & Age\in[75,\infty) & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & Age\in[18,65) & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & Age\in(0,18) & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & Age\in[6,18) & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & Age\in[18,45)
\end{bmatrix}
\begin{bmatrix}
Heart\ \ failure \\
Renal\ \ insuff. \\
Cancer \\
Tuberculosis \\
Stroke \\
Congenital \\
Transplant \\
HIV
\end{bmatrix} \\
&Let\ \ B=[\beta_1\ \beta_2\ \beta_3\ \beta_4\ \beta_5\ \beta_6\ \beta_7\ \beta_8] = [1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1] \\
&B:\ Effect\ Matrix;\ \ A:\ Age\ Matrix;\ \ C:\ Comorbidity\ Matrix
\end{aligned}
$$

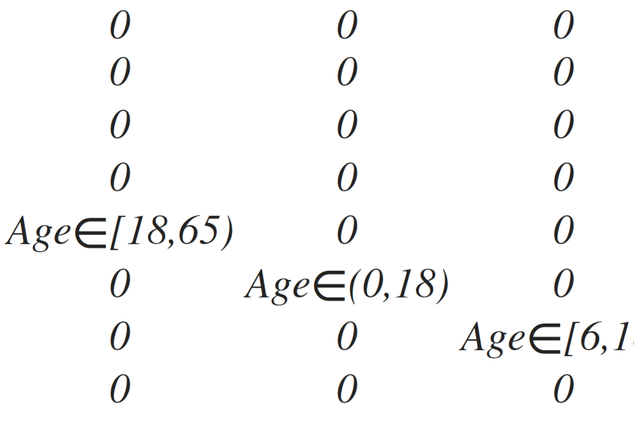
Effect of Score + 1 (adjusted for sex and age)

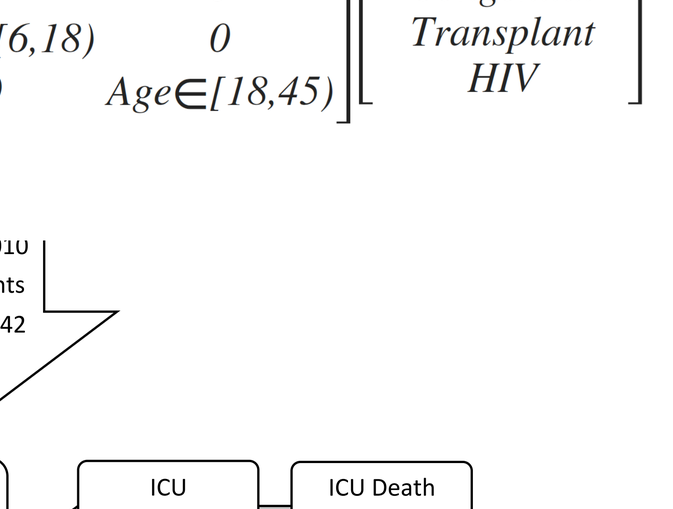
Outcomes	Statistics	Effect	95% CI		p
Cost	Ratio	1.44	1.42	1.45	<0.0001
LOS	Ratio	1.26	1.25	1.27	<0.0001
Death	OR	1.21	1.19	1.23	<0.0001
ICU	OR	1.87	1.84	1.91	<0.0001











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