Mobile Phone Based Healthcare Platform for Assisting Lung Cancer Prevention

Jun Yang¹, Bowei Chen² and Jing Liu¹,²,*

¹Department of Biomedical Engineering, School of Medicine, Tsinghua University, Beijing 100084, China
²Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, Beijing 100190, China

Abstract: We developed a personal interactive management platform based on Android system called lung cancer prevention assistant. A mathematical model for quantifying the cancer occurrence risk was established. This healthcare system collects user’s lifestyle events, such as tobacco smoking and diet structure, as input parameters. After comprehensive and quantitative analysis, the system would figure out the relative risk (RR) value of lung cancer morbidity and suggest guiding tips for lung cancer prevention. People with Android smart mobile phone or PDA (Personal Digital Assistant, such as widely used Pad) can access this management system easily, with the fact that Android smart phone is widely used over the world. This may possibly reduce the cost of medicine paid on the treatment and recovery of cancer. Advantages and possible applications of the present system were outlined. We also discussed the shortage of the lung cancer prevention assistant and suggest its potential solutions in the near future.

Keywords: Lung cancer prevention, Android, Health management system, Mobile health.

1. INTRODUCTION

The worldwide lung cancer had become one of the leading causes of preventable death, at the end of the 20th century [1]. In China, the cases of lung cancer have increased by 50%, from the mid-1970s to early 1990s [2]. Researchers and medical practitioners have long focused on cancer prevention. The fact that only 5–10% of all cancer cases are due to genetic defects and that the remaining 90–95% are due to lifestyle factors (including smoking, diet, alcohol, physical inactivity, obesity and sun exposure), infections and environmental pollutants provides major opportunities for preventing cancer [3]. Furthermore, tobacco smoking remains the major risk factor on the incidence of cancer, with 90% of all lung cancers occurring in smokers [1]. Besides the well-known cause (tobacco smoking), beginning in the 1980s, associations of diet with lung cancer risk have been vigorously investigated [1]. Large number of epidemiological studies focused on one or several exposure factors on the incidence of lung cancer. All these studies point out that non-smoking and healthy diet is helpful to cancer prevention. Actually, maybe everyone agree that this conclusion is self-evident. However, until today there is still no an effective method to achieve this goal. Clearly, smoking is harmful to health. But people would always just forget to quit smoking. And they do not have a quantitative understanding of how harmful of smoking to the lung. Aiming to provide an auxiliary tool to help people prevent lung cancer, here we developed for the first time an interactive method and software based on Android system, which can be used in mobile phone for such purpose. After given two parameters, family lung cancer history and the smoking history, the lung cancer prevention assistant system would figure out a RR value as user’s initial record. After that, user could use the system to record exposure factors, which he or she has been exposed to daily, and the application will calculate RR value. In this case, the history of RR value can be displayed as a curve. So that user can find out how his or her RR value changes day by day. In this way, a better health care management can be carried out day and night.

2. PRINCIPLE AND METHOD

2.1. About Relative Risk (RR)

In statistics and mathematical epidemiology, RR is a measure of association between exposure to a particular factor and risk of a certain outcome. The RR is defined to be the ratio of risk in the exposed group versus unexposed group [4], i.e.

\[ RR = \frac{P_{\text{exposed}}}{P_{\text{unexposed}}} \]  

An equivalent term for RR that is sometimes used in epidemiology is the cumulative incidence ratio, which may be calculated as follows: RR is equal to the risk among exposed subjects divided by the risk among unexposed subjects [4], i.e.
where, $I_e$ is exposed group mortality, $I_u$ indicates unexposed group mortality. Considering lung cancer as an example, $RR=1$ represents no association between lung cancer and the studied exposure factor. $RR>1$ represents a positive correlation between lung cancer and the exposure factor. That is to say, the studied exposure increases the risk of lung cancer. $RR<1$ represents a negative correlation between lung cancer and the studied exposure factor. In other words, the exposure factor decreases the risk for lung cancer [5]. Generally, exposure factor, with $RR$ less than 1, is healthy, and exposure factor, with $RR$ more than 1, is harmful.

### 2.2. Exposure Factor of Interest

Lung cancer was first recognized in the late 19th century because of mineworkers of Germany’s fatal disorder of lung. At decades, lung cancer was recognized as an occupational disease [2]. The occupational factors generally would cause air pollution. In other words, certain air pollution is a high-risk factor for lung cancer. However, considering the calculation limitation of mobile phone, we ignored the factor of air pollution. Until a case controlled study was published by Muller in 1940, in Germany, in which a statement was made that tobacco smoking was the single most important cause of the rising incidence of lung cancer [2]. It is believed that 90% of lung cancer cases are due to lifestyle factors, such as smoking and diet, which are controllable however. In order to find out the initial $RR$ value, we also consider the history of family lung cancer.

### 2.3. Smoking-Related $RR$

Tobacco smoking or cigarette smoking (smoking for short) is the major cause of lung cancer. Relative risk of lung cancer increases with quantity of cigarettes smoked, duration of smoking, and depth of inhalation. Also smoking start age and years of smoking cessation affect the $RR$. A meta-analysis of studies on the association between smoking and risk of lung cancer is published by Wang et al. [6]. We mainly used the $RR$ value in their paper. Additionally, for simplicity, we ignored the confidence interval and only use the maximum likelihood value of $RR$ for the analysis (Table 1).

### 2.4. Diet-Related $RR$

There have many studies to assess the association between dietary intakes and risk of lung cancer. The World Cancer Research Fund (WCRF) has done significant work for cancer prevention. The book Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective is much valuable to both researchers and general people. Thanks to their work, we mainly summarized the association between risk of lung cancer and diet from there (Table 2).

### 2.5. History of Family Lung Cancer-Related $RR$

A systematic review finds a significant increase of lung cancer risk associated with history of family lung cancer.
cancer [10]. Difference of risk between smoker and non-smoker has also been recognized. But the difference is small enough to be ignored. Table 3 illustrates RR association between history of family lung cancer and morbidity of lung cancer.

Table 3: Relative Risks (RR) of Lung Cancer—Association Between Lung Cancer and History of Family Lung Cancer [10]

<table>
<thead>
<tr>
<th>History of Family lung cancer</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>1.84</td>
</tr>
</tbody>
</table>

2.6. Determination of Initial RR Value

As mentioned above, we use two factors, smoking history and the history of family lung cancer, to figure out the initialization RR value. Different state of smoking means different association with the risk of lung cancer. To obtain the detailed smoking history, a questionnaire is used which is illustrated by Figure 1.

Here, we treat RR value as probability. According to the basic probability theory, the probability of two independent events is the product of the probability of the two events respectively. Based on this hypothesis, initial RR is calculated as:

$$RR_{ini} = RR_{som} \times RR_{flh}$$  \hspace{1cm} (3)

where, $RR_{ini}$ is initial RR value and $RR_{som}$ is the RR value decided by smoking history (Table 1), and $RR_{flh}$ is the RR value decided by history of family lung cancer (Table 3).

Different smoking status, for instance smoking duration less than 20 years ($RR=1.25$) and starting smoking before 15 years old ($RR=13.31$), represent different RR value (Table 1). We use the maximum value as $RR_{som}$ value. Obviously, if smoking history is none, $RR_{som}$ would be 1. As to $RR_{flh}$ value, it is 1.84 with the history of family lung cancer and 1 without the history of family lung cancer.

2.7. Calculation of Daily RR

We are interested in several exposure factors such as smoking amount and diet content (Table 2) every day. Let $EF_i$ (i for 1 to n) donates a special exposure factor, and $RR_i$ donates its RR value. Otherwise, $RR_i$ equals to 1. Let $RRD_k$ donates today’s RR, and $RRD_{k-1}$ is yesterday’s RR. One can then calculate today’s RR using the following formula:

$$RRD_k = RRD_{k-1} + \log \left( \prod_{i=1}^{n} RR_i \right)$$  \hspace{1cm} (4)

Clearly, if user is exposed to exposure factor $EF_i$, $RR_i$ is the value as shown in Table 1 or Table 2.

3. APPLICATION DEMONSTRATION

Based on the above principle, we developed an application system based on Android platform, which achieved the major features as described above. Here, considering the application is mainly tested in our local

![Figure 1: Investigation of smoking history.](image-url)
areas, the present software is developed with user interface in Chinese. We expect to convert it into English in the coming time. In this paper, we would explain the corresponding meanings of the software operations by the words in the text. In order to protect personal privacy data, user with both right user name and password can access the application (Figure 2).

There is another tab UI besides the login tab as Figure 2 illustrated in Chinese characters. This tab contents some fundamental knowledge about lung cancer prevention, which is “What is lung cancer”, “Lung cancer can be prevented” and “How to prevent lung cancer”. Without log in, user can have a review about lung cancer prevention, which will help people to keep away from lung cancer.

Suppose Jun is a new user. He input his name Jun in the user name box, and let the password to be null, which is also supported. First of all, Jun wants to enter his personal data like history of smoking and the family lung cancer history (Figure 3). As Figure 3 shows, Jun can still learn some knowledge about lung cancer prevention after login. Suppose Jun has never smoked but his father suffered from lung cancer unfortunately. After he entered this information, His initialization RR value will be 1.84. RR will be shown in the Daily Investigation tab page (Figure 4).

After then Jun needs to click the New Record button to finish the investigation every day. The investigation items include smoking amount and diet content (Table 2). After the New Record button was clicked, Jun wants to set today’s date. The date of the system will be shown for easy use (Figure 5).
In most cases, the OK button can be clicked. There are several pages for investigating. The first page is about smoking amount. Jun smoked three cigarettes today, so he puts 3 in the input box. Jun can slides left or right to switch to another page (Figure 6). After investigation, Jun clicks the Done button. The new RR value will be displayed in the Daily Investigation tab page.

And the history RR value can be depicted as a 2D discrete figure (Figure 7). Jun only needs to click the Show History button.

4. DISCUSSION AND CONCLUSION

An effective way to prevent lung cancer is to identify the numerous exposures that are causally associated with lung cancer. If steps can be taken to reduce or eliminate the population’s exposure to these agents, this would be expected to reduce the population’s risk of lung cancer [11]. Daily lifestyle especially cigarette smoking is causally associated with lung cancer [12-17]. Mobile phone or e-health has shown promise in helping healthcare in now individual medical healthcare era [18-20].

The most advantage of the lung cancer prevention assistant system is that it at least can give people a quantitative concept of daily life associated with lung cancer morbidity ignoring the accuracy of quantitative RR. Besides, the record of daily life is a prompt for people to give up smoking and develop a healthy diet plan. With such prevention tips, people can manage
their life more easily and rationally. In this sense, it would definitely help improve one’s lifestyle.

However, there does exist certain shortages in this lung cancer prevention assistant system so far. First of all, the exposure factors associated with lung cancer morbidity, which were considered in this paper, are still far away from completeness. Food contamination and air pollution are partly associated with lung cancer morbidity. Especially occupational pneumoconiosis, because of long-term inhalation of dust, tends to lead to lung cancer easily without effective prevention methods. The RR value of each exposure factor may not be applicable to every people because of the differences in the structure of diet nutrition, which was mainly caused by regional differences. We ignore the regional differences when collecting RR value. This will increase the uncertainty of the assessment. The accuracy of the assessment result cannot be guaranteed, because of the obvious reason that the RR value of each exposure factor we got from the research papers is a long-term accumulation of this exposure factor acting on people. However, we used it to estimate everyday relative risk. These factors mentioned above have increased the uncertainty of the assessment. For brevity, we have not done additional work to evaluate the accuracy of the assessment results which needs large scale clinical test.

Theoretically speaking, more variant associated factors can be involved in the system. It is obvious that the more the lung cancer occurrence related factors are included, the more accurate the estimated everyday relative risk will be. As to environmental factors, we have not found so far any published papers regarding cohort study on the data contributing to lung cancer occurrence risk. Therefore at this stage, we still can not get such Related Risk (RR) value, which is highly depended by the analysis. Nonetheless, the environmental factors can be included in the software application. For instance, one can propose some recommendations on outdoor activities based on local Air Pollution Index. It is of no doubt that occupational carcinogens are serious threats to relevant workers. However, occupational factors are uncontrollable unless those people change their jobs. It is believed that everyday protective methods are the most effective way to protect relevant workers. This study still did not consider the lifestyle to estimate the initial RR considering that it is not easy to get the history detail lifestyle such as diet construction. The quantitative model in the present system is not perfect. Its accuracy can be improved by a well-designed randomized control trial in the future along this direction.

Future work would be like testing the effects on people who use the lung cancer prevention system. The effects should include both the accuracy of assessment results and the smoking cessation rate. If this management system was demonstrated to work well, one can extend the method to other kinds of cancer. The present paper suggests a generalized mobile health care way for future cancer prevention.

ACKNOWLEDGEMENTS

This work is partially supported by the 863 project of China.

REFERENCES


[13] Roswalla N, Olsena A, Christensen A, Dragsted LO, Overvad K, Tjønneland A. Source-specific effects of
http://dx.doi.org/10.1016/j.lungcan.2009.11.010

http://dx.doi.org/10.1016/S0169-5002(01)00330-0


http://dx.doi.org/10.1016/j.lungcan.2011.07.004

http://dx.doi.org/10.1016/j.lungcan.2009.05.017


http://dx.doi.org/10.1016/j.amepre.2010.10.032

http://dx.doi.org/10.1016/j.amepre.2007.01.016

Received on 28-05-2012 Accepted on 02-06-2012 Published on 21-08-2012

DOI: http://dx.doi.org/10.6000/1929-2279.2012.01.01.13