Is utilisation of computed tomography justified in clinical practice? Part I: application in the emergency department

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ABSTRACT
Computed tomography (CT) is currently a widely available imaging technique in clinical practice. Technical developments of CT imaging, especially the emergence of multislice CT, with increased scanning speed and volume as well as higher spatial and temporal resolution, have significantly enhanced the diagnostic value of CT in many clinical applications. CT has become an important diagnostic imaging modality in the emergency department, with high diagnostic accuracy and efficacy in both traumatic and non-traumatic conditions. There is, however, a growing concern about the risk of associated radiation exposure in the population exposed to CT examination. Justification of the application of CT is one of the main principles that physicians need to be aware of when choosing CT as the first-line technique for diagnosis. This article reviews the clinical applications of CT imaging in the emergency department, with a focus on patients presenting with headache, repeat and multiple CT imaging and whole body screening for trauma patients, and explores whether the applications are clinically justified.

Keywords: computed tomography, emergency department, radiation dose, radiation risk, trauma

INTRODUCTION
Since its first introduction into clinical practice in the early 1970s, the use of computed tomography (CT) has been progressively growing worldwide. According to the 2006 report\(^1\) of the United Nations Scientific Committee on the Effects of Atomic Radiation, the average frequency of CT examinations in developed countries increased yearly from 6.1 per 1,000 population in the 1970s to 48 per 1,000 population in the period between 1991 to 1996.\(^2\) During the last two decades, CT has undergone rapid technical developments, including the introduction of helical and multislice CT scanners which decrease or eliminate motion artifacts, acquire volumetric data in a short time with great anatomic coverage and generate isotropic datasets which facilitate the 3D reconstruction of anatomical areas.\(^3,4\) These advantages have led to a rapid increase in the utilisation of CT in both adults and children.\(^5,6\) The estimated annual number of CT examinations in the United States rose steadily from 2.8 million in 1981 to 20 million in 1995,\(^7\) 46 million in 2000\(^8\) and more than 62 million in 2006, including 4 million for children.\(^9\) Comparable trends have been reported in European countries such as Germany, Switzerland, Norway and the United Kingdom.\(^10\) All these data indicate that CT has become the diagnostic method of choice in many clinical applications in both daily practice and emergency departments.

It is estimated that CT accounts for 10% of all diagnostic radiologic examinations, but it contributes up to 70% of the collective radiation dose delivered to patients.\(^11\) The growing use of CT is accompanied by growing concerns about the risks associated with diagnostic CT. The risk is estimated by looking at the expected number of cancers in a specific population and the actual numbers observed in the exposed cohort.\(^12\) The National Academy of Science has published a series of reports about the health risks of radiation exposure, called the Biological Effects of Ionizing Radiation (BIER VII) reports. It is estimated in the reports that a single population dose of 10 mSv is associated with a lifetime risk for developing a solid cancer or leukaemia by one in 1,000 exposures.\(^13\) The small potential risk of cancer associated with CT must be considered in the context of the potential survival benefit from undergoing CT examination. Tables I and II show the radiation dose of CT examination in various anatomic regions in comparison to the radiation dose resulting from corresponding conventional radiography.\(^14\) As McCollough et al claimed,\(^15\) the life risk of a fatal cancer from all causes is 22.8%, and the lifetime potential risk of a fatal cancer from the radiation associated with a body CT scan is approximately 0.05%.