Life-cycle CO2 Reduction Potential through the Operational Efficiency Improvements in the Japanâ€™s medical sector

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CO2 emissions from medical sector account for 4.6% of the total CO2 emissions in Japan in 2011 and it is crucial to mitigate its emissions through a relevant policy. The medical sector is capita-intensive and it needs a wide variety of capital equipment to provide medical services. In addition, the number of capital equipment such as diagnostic imaging devices of computed tomography (CT) and magnetic resonance imaging (MRI) mainly used in hospitals has rapidly increased by 60.2% between 1999 and 2020 due to the Japanâ€™s aging society and the capital- intensive activity has contributed to increasing the life-cycle CO2 emissions via material and energy consumptions. It should be noted that the number of these devices installed in the hospitals per capita largely varied between prefectures in Japan. Data also shows that a negative correlation existed between the number of devices per capita and the number of medical examinations (i.e., provision of medical services) in prefectures, implying that the equipment are being used inefficiently. We examine the potential of reducing costs and life-cycle environmental impacts through optimal allocation of CTs and MRIs among 47 prefectures of Japan by using a new method modelled by both data envelopment analysis (DEA) and life-cycle analysis (LCA). For the empirical analysis, we use a comprehensive hospital database including the number of CT and MRI introduced in hospitals in 47 prefectures of Japan, the number of radiology technologists and the number of radiologists employed in the hospitals, and the actual number of their medical examinations in the hospitals and estimate the relative operational efficiency of each prefecture through the DEA. The DEA results show that prefectures with the highest operational efficiency score of 1 are mostly found in east regions of Japan such as Hokkaido, Kanto (Saitama, Chiba, Tokyo, and Kanagawa), and Chubu (Nagano, Aichi). Prefectures with lower operational efficiency score are located in Kyushu (Fukuoka (0.728), Oita (0.707), Saga (0.705), Kumamoto (0.601), Miyazaki (0.593)), and Shikoku (Kagawa (0.751), Kochi (0.642)). Thus, there was a large efficiency gap in the Japanese hospitals. We also find that the cost reduction potential nationwide is estimated to be 313 billion yen, and the CO2 emission reduction potential from reducing devices is 732 kt-CO2e, which accounts for approximately 1% of the life-cycle CO2 emissions from the healthcare sector in Japan. It is important to note that 42.4% of hospitals of Japan responded â€œnot muchâ€• or â€œnot at allâ€• in a questionnaire survey on future energy reduction opportunities for hospitals. Thus, the questionnaire survey result shows that approximately 40% of hospitals are stuck with measures to reduce their environmental impact. On the other hand, the CO2 emission intensity target described in the â€œAction Plan for Low Carbon Society in Hospitalsâ€• is a 1.57% reduction from the previous year. Therefore, we conclude that there exists a large potential for CO2 emission reduction through efficient use of capital equipment in the Japanâ€™s medical sector. The government should promote reallocation of equipment and joint use among medical institutions in the future to prevent further environmental burden caused by inefficient equipment operation.