We thank J. N. McCutcheon, X. Zhao, and G. Giaccone for their insightful commentary on our article regarding genomic studies for large-cell neuroendocrine carcinoma (LCNEC) of the lung (1). We would like to take this opportunity to comment on some of the points that they raised and to discuss our data reported in the original manuscript further (2).

Although LCNEC is distinguished from small cell lung carcinoma (SCLC) based on histological criteria such as a larger cell size and abundant cytoplasm, LCNEC shares many similarities with SCLC in terms of immunohistochemical (IHC) staining results and molecular biology (3,4). However, a multi-center prospective phase II study examining combination chemotherapy with irinotecan and cisplatin resulted in a somewhat poorer outcome among LCNEC patients than among those with SCLC (5), suggesting a possibility of biological distinction between LCNEC and SCLC. Due to its rarity, information about biologically relevant genetic alteration in LCNEC is insufficient. Thus, we examined LCNECs for biologically relevant genomic alterations using next-generation sequencing (NGS) and compared the genomic profiles of LCNECs with those of SCLCs.

McCutcheon et al. pointed out that we have proposed the ongoing movement in genomics to deliver “personalized” treatment approaches to patients with LCNEC (1). We reported that a group of LCNEC patients harbored targetable activating alterations in receptor tyrosine kinase signaling pathways, such as the PI3K/AKT/mTOR pathway and EGFR, ERBB2 and FGFR1 (2). Our results showed that sequencing-based molecular profiling is warranted, since it was capable of identifying a population of LCNEC patients who were likely to benefit from novel targeted therapies even if it was a small population.

Our results showed that LCNEC and SCLC had similar genomic profiles (2). LCNEC is a rare disease, so NGS-based analyses might be helpful for developing novel targeted therapies along with other types of lung cancer, such as SCLC. Rekhtman et al. also reported that the TP53 and RB1 genes were the most commonly mutated genes in LCNEC, in agreement with our data; however, they showed that LCNEC represented a biologically heterogeneous group of tumors with distinct subsets exhibiting the genomic signatures of SCLC, NSCLC, and, in rare cases, highly proliferative carcinoids (6). Although the more than 200 genes that are included in the target-sequencing panel encompass most known, functionally important cancer-related genes, studies utilizing whole-genome/exome sequencing technologies will be desirable to obtain a detailed understanding of the similarities between LCNEC and SCLC. In addition, analysis of a larger cohort of cases will be needed to capture a full spectrum of genomic profiles in LCNEC.

As McCutcheon et al. pointed out, the genomic analysis
of combined LCNEC is challenging (1). We found that 5 of
the 10 cases of LCNECs combined with NSCLCs harbored
candidate driver gene alterations that have been previously
reported for NSCLC. We diagnosed combined LCNEC as
follows: LCNEC with an additional component of some
other NSCLC histology that was clearly separated from the
LCNEC component. In most cases, the size of the NSCLC
component in the combined LCNEC was relatively small.
Therefore, we used the core of the specimen for DNA
extraction to obtain as much DNA sample as possible. In
this study, the median and mean read coverages for all the
LCNEC samples (including the NSCLC components)
were 360 and 359, respectively. To avoid contamination,
pathologists reviewed all the tumor samples before and
after tissue punching and evaluated the tumor cell contents
of the punched-out sites: a minimum of 50% tumor
cells were included in all the samples, and no additional
micro-dissection was needed. The variant frequency of
the mutations in the NSCLC component tended to be
lower than that shared with the LCNEC component. We
suppose that the tumor contents in the NSCLC component
were generally less than those in LCNEC component.
The relatively high concordance rate might be due to the
common origin of different components and not due to
contamination of the samples during the DNA extraction (2).

LCNEC is a rare and lethal disease with no approved
disease-specific targeted therapies (7). Ongoing efforts to
collect and analyze samples using more advanced research
tools are likely to enable the development of effective
and novel targeted therapies. Integrated omics analyses,
including RNA sequencing and metabolomics as well as
whole exome or whole genome analyses, might provide a
stronger interpretation of the LCNEC biology. In addition,
co-clinical studies using patient tumor-derived and/or
circulating-tumor cell derived xenografts could be used to
guide therapeutic strategies for individual patients in the
same way as those for SCLC (8,9).

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest
to declare.

References

1. McCutcheon JN, Zhao X, Giaccone G. A genomic
analysis of large cell neuroendocrine carcinoma versus
small cell lung cancer: which is which? Transl Cancer Res
2016;5:S1088-S1092.
Profiling of Large-Cell Neuroendocrine Carcinoma of the
prognostically significant subtypes of high-grade lung
neuroendocrine tumours independent of small-cell and
large-cell neuroendocrine carcinomas identified by gene
profiling of receptor tyrosine kinases in high-grade
neuroendocrine carcinoma of the lung: a comparative
analysis with adenocarcinoma and squamous cell
chemotherapy with irinotecan and cisplatin for large-cell
neuroendocrine carcinoma of the lung: a multicenter phase
Next-Generation Sequencing of Pulmonary Large
Cell Neuroendocrine Carcinoma Reveals Small Cell
Carcinoma-like and Non-Small Cell Carcinoma-like
7. Travis WD, Brambilla E, Nicholson AG, et al. The
2015 World Health Organization Classification of Lung
Tumors: Impact of Genetic, Clinical and Radiologic
Advances Since the 2004 Classification. J Thorac Oncol
2015;10:1243-60.
and genetic profiling of circulating tumor cells in small-
DLL3-targeted antibody-drug conjugate eradicates high-
grade pulmonary neuroendocrine tumor-initiating cells in

Cite this article as: Umemura S, Miyoshi T, Ishii G, Tsuchihara
K. Treatment approach for large-cell neuroendocrine carcinoma
of the lung using next-generation sequencing. Transl Cancer Res
2017;6(Suppl 2):S448-S449. doi: 10.21037/tcr.2017.03.51