

FROM THE ANALYST'S COUCH

Immuno-oncology drug development goes global

Jia Xin Yu, Vanessa M. Hubbard-Lucey and Jun Tang

Immunotherapy has become an essential pillar for cancer treatment, and the drug development space continues to attract numerous organizations that aim to transform scientific innovation into practice-changing cancer drugs. In the current analysis, we provide the latest update of the global immuno-oncology (IO) drug pipeline development, comparing our first survey conducted in September 2017 with our most recent survey conducted in August 2019.

Expansion of new IO pipeline drugs

The number of active drugs in development has grown from 2,030 to 3,876, a 91% increase from 2 years ago. Among the six different drug classes, cell therapy represents the largest growth during this period, adding 797 new active drugs to the pipeline in the past 2 years. At the opposite end, the oncolytic virus class has seen the smallest growth, with only 31 new agents added to the pipeline (FIG. 1). In terms of clinical trials, we identified 5,166 active trials in the clinicaltrials.gov database that are testing pipeline drugs. Although only 212 compounds in the T cell-targeted immunomodulator class are currently in clinical trials (accounting for fewer than 6% of all active drugs in development), there are 3,428 active clinical trials evaluating such agents, which is an overwhelming

66% of all active trials testing IO agents (Supplementary Fig. 1).

New targets added to the pipeline

Compared with our first survey in 2017, we found that 205 new targets have been added to the current landscape of 468 active targets, which represents a 78% increase over the past 2 years (Supplementary Fig. 2). When we looked at the top 15 specific IO targets in 2017 and 2019, 10 targets made both lists: CD19, PD-1, PD-L1, CTLA-4, HER2, HPV, IDO1, NY-ESO-1, CSF1R and STAT3. In particular, CTLA-4, PD-1, PD-L1, CD19 and CSF1R already have approved IO drugs in the market (FIG. 2). Looking at the targets within the different IO drug classes, we found that T cell immunomodulators, other immunomodulators and cell therapies had the largest increase in new targets in the past 2 years, which suggests that more innovation is going into these drug classes than the other IO drug classes (Supplementary Fig. 3).

The US leads the global IO pipeline

Examining the geographical distribution of IO agents in the current pipeline, we found that 1,837 active agents are being developed by organizations (both companies and academic institutions) in the United States (US), which represents 47% of the whole pipeline. Companies from China account



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for another 614 active agents (16% of the pipeline). In fact, most of the IO drug development (3,381 active IO agents, 87% of the global pipeline) concentrates in ten countries, including the US and China. The pipeline in the US shows a more even distribution among different IO drug classes than that from China, which is dominated by cell therapies (61% of the total pipeline) (FIG. 3). In terms of the current top 15 clinical pipelines by different organizations, we found that most of them added more new agents to their portfolios in the past 2 years. We also found that the multinational pharma companies are leading the clinical development of IO agents, similar to our survey findings in 2017 (Supplementary Fig. 4).

Conclusion

Since our first global IO pipeline survey in 2017, the field has grown substantially, exemplified by a 91% increase in the number of active agents, 78% increase of active IO targets and 60% increase in participating organizations. This tremendous investment and commitment from different sectors have laid the foundation for 31 approvals by the FDA for IO drugs in the past 2 years. Looking at the continuously growing investment in the IO space, one would expect that more

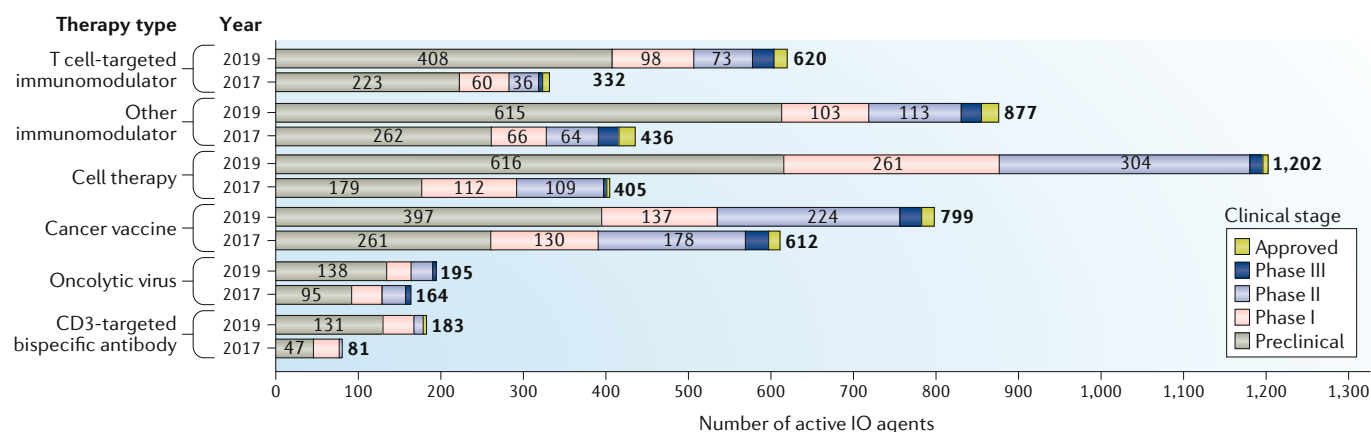


Fig. 1 | **Overview of all 3,876 active IO agents in the current global drug development pipeline.** In the past 2 years, 1,846 new agents have been added to the immuno-oncology (IO) pipeline, an increase of 91%.

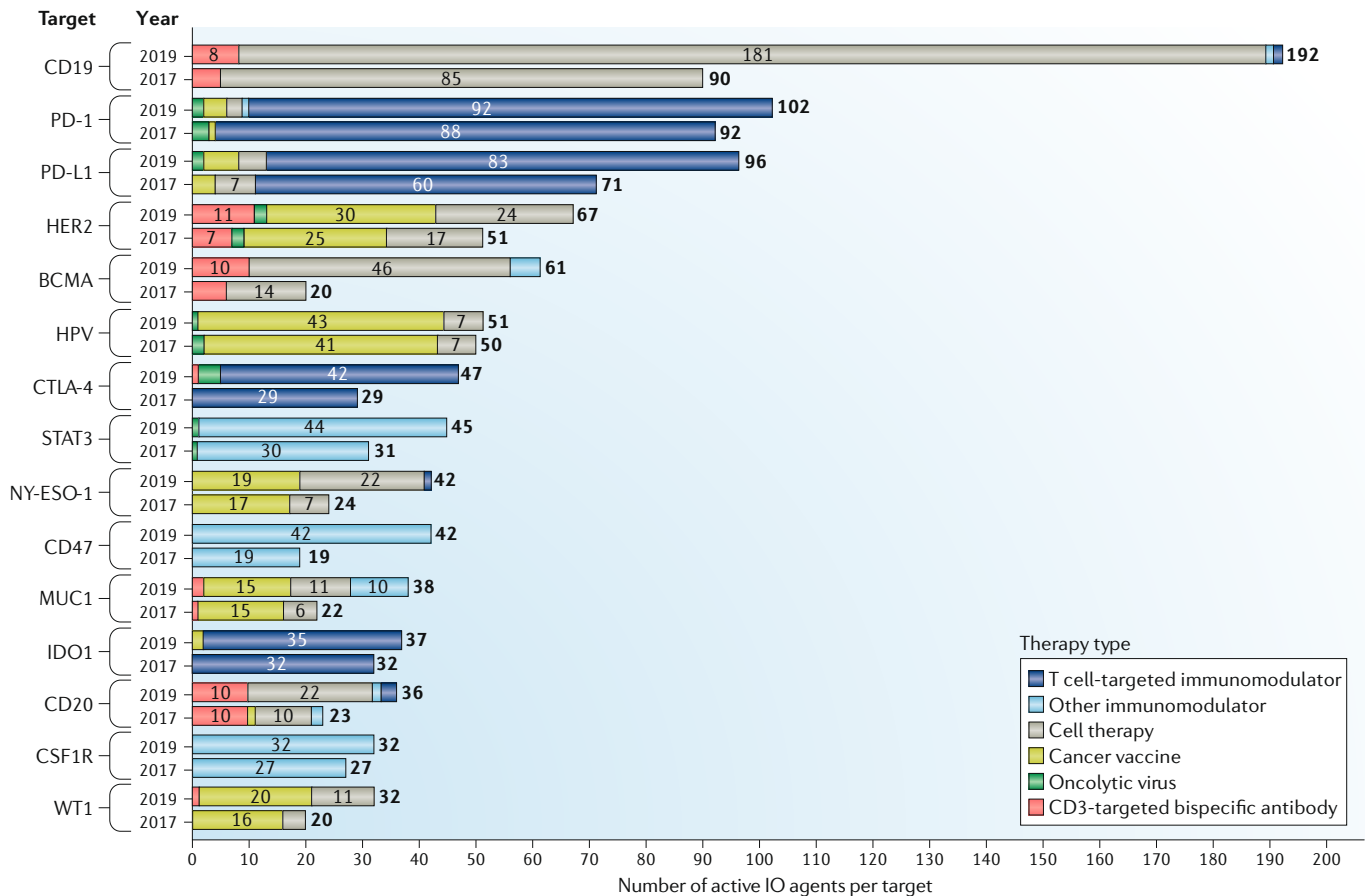


Fig. 2 | **Top 15 specific IO targets in the current pipeline, compared with 2017.** Five of the top 15 targets have at least one approved drug, namely CD19 (blinatumomab and others), PD-1 (pembrolizumab and others), PD-L1 (atezolizumab and others), CTLA-4 (ipilimumab) and CSF1R (pexidartinib). IO, immuno-oncology.

paradigm-shifting therapies are on the way. Of note, although the US still leads the global IO pipeline, the aggregation of active IO agents from all other countries now account for more than 50% of the pipeline. This encouraging dissemination of IO activity from one country to many others may bring, in our opinion, more innovation to the global IO space

and benefit more patients with cancer worldwide.

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<https://doi.org/10.1038/d41573-019-00167-9>

Competing interests

The authors declare no competing interests.

Supplementary information

Supplementary information is available for this paper at <https://doi.org/10.1038/d41573-019-00167-9>.

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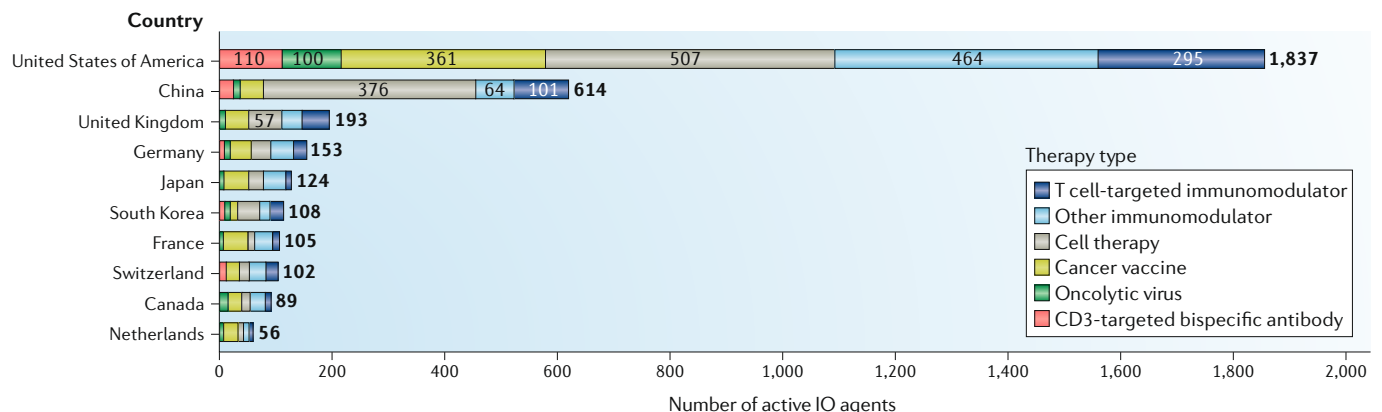


Fig. 3 | **The top 10 countries with most active pipeline IO agents in development.** The US and China have the largest pipelines among all countries, but the US pipeline has more diversity among different drug classes than that from China. IO, immuno-oncology.