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# Insights from Drug Discovery Life Cycle Management in Pharmaceutical Industry: A Case-study

***B. Thomas[1] and P. Chugan[2]***
*[1]Research Scholar, Institute of Management, Nirma University, Ahmedabad (Gujarat), India.*
*[2]Professor (Retd.), Institute of Management, Nirma University, Ahmedabad (Gujarat), India.*

*(Corresponding author: B. Thomas)*
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**ABSTRACT: The Biotechnology and Pharmaceutical Industry has always stood up to the challenge of discovering innovative products fulfilling high unmet medical needs for mankind. The drug discovery and development pathway is very challenging and time consuming from efficacy, safety, regulatory and investments perspective. Hence, there is a significant need for collaboration among the biotechnology and large pharmaceutical companies to develop and commercialize their product innovations across the globe. This paper reviews the discovery and development of Selumetinib by Array Biopharma from year 2000 to 2019 when the USFDA accepted the first NDA filing for neurofibromatosis type one (NF1) disease. Array biopharma successfully developed several other drugs to the marketplace and several drugs to late stage registration trials either itself or in collaboration with strategic partners. These strategic partnerships helped mitigate risks in drug development and registration. This study of the clinical, regulatory and partnership strategy untaken for Selumetinib has created important contribution in the field of product life cycle management in the pharmaceutical and biotechnology industry.**

**Keywords:** Product development, drug development, life-cycle management, strategic partnership.

**Abbreviations:** R & D, Research and Development; CML, Chronic Myeloid Leukemia; RAI, Radioactive Iodine; NF1, Neurofibromatosis Type 1 (NF1); PNs, Plexiform Neurofibromas; DTC, Differentiated Thyroid Cancer; USFDA, United States Food and Drug Administration; NDA, New Drug Application.

## I. INTRODUCTION

The last few decades have witnessed exponential progress in our understanding of science, genes, and its relationship with human diseases like cancer and cell death. The drug development process takes on an average 10 to 12 years to bring a new drug into the marketplace [1]. However, even before the process of drug development begins, years are spend on target identification, target validation and then designing molecules that can eventually be developed as drug candidates [2].

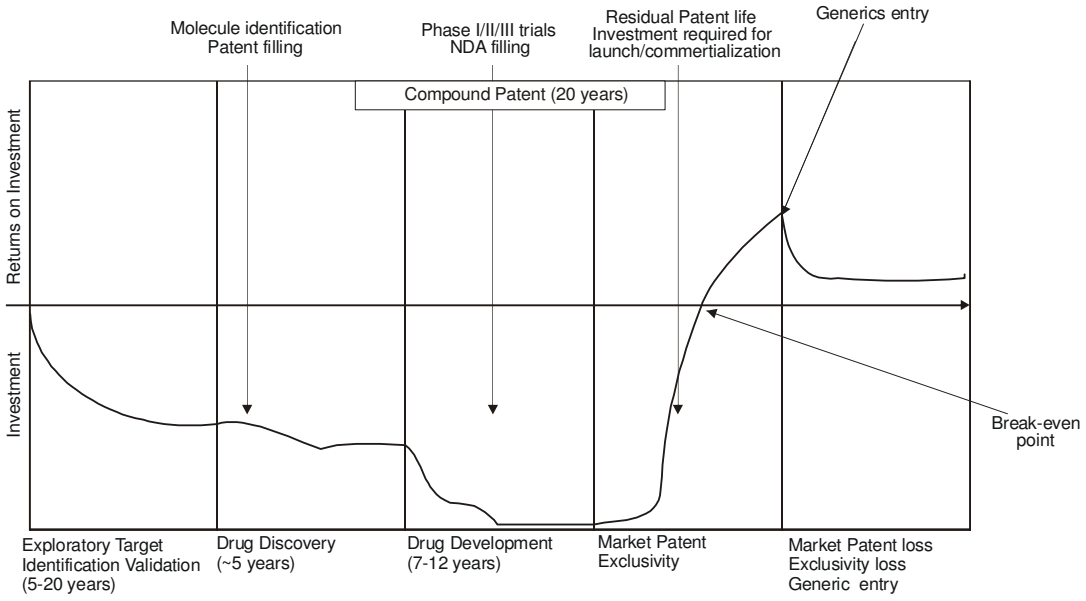


**Fig. 1.** Product life-cycle of drugs.

Research institutes and biotech companies have been a rich source of new innovative molecules [3]. However, the small biotech companies often lack the investments required for doing late stage drug development, manufacturing and commercialization [4]. Novel ideas can originate from institutes in different parts of the world that can be developed into medicines [5]. On the other hand large pharmaceutical companies which have deep expertise in drug development, product life cycle management [6], and large research and development pipelines are always in need to identify and develop new drugs to the marketplace [7].

The patents are granted for a period of 20 years, however, significant part of the patent life is lost during the drug development process, hence product life cycle management is important once the drug has been approved so that the pharmaceutical company can provide the medicines to patients in need [8]. The product life cycle management is also important in the earlier stages of product discovery and development to ensure that minimum time of effective patent life is lost in the process [9]. For biotech companies lacking capital or expertise, another pharmaceutical company with the capital, experience and expertise in drug development could be the ideal partner.

## II. OBJECTIVES AND METHODOLOGY

The objectives of the study was to evaluate the development of Selumetinib. Another important objective was to study the partnership strategy of Array Biopharma in developing Selumetinib for value creation.

The biotechnology company Array Biopharma was selected to analyze the strategy being followed by the company in drug discovery and development. Further the development, licensing partnerships of Array biopharma was profiled to understand its life cycle management strategies. Data was collected on the discovery and clinical development of Selumetinib from the period 2000-2019 from secondary sources. The molecule Selumetinib was further evaluated in detail to study its development, combinations and partnership strategy.

## III. RESULTS AND DISCUSSION

*A. Array Biopharma and the Discovery of Selumetinib*

Array Biopharma was a Colarado, USA based Biotechnology Company focused on the discovery, development and commercialization of drugs for the treatment of cancer. The company used to be a Research and Development (R & D) discovery unit of legendary biotech company, Amgen, but when Amgen decided to close the Denver facility because of strategic reasons, the senior executives incorporated Array Biopharma Inc. on February 6, 1998 [10].

Array Biopharma rapidly went forward to develop a pipeline of candidates in drug discovery and development and had 18 programs in various stages of clinical development by August 2019. The company has successfully licensed 15 of its programs to other pharmaceutical and biotech companies worldwide.

Selumetinib (Sr. No 3) was discovered at Array Biopharma. It was an oral small molecule with potent anti-neoplastic activity. RAS/RAF/MEK/ERK pathway are upregulated in various cancer cells. MEK-1 and MEK-2 are dual-specificity kinases that mediate the activation of this RAS/RAF/MEK/ERK pathway. Selumetinib works by inhibiting the activation of MEK-1 and MEK-2 and thus stops the cellular proliferation in various cancers.

**Table 1: Array Biopharma Inc pipeline (as of August 2019).**

| S. No. | Molecule | Target | Indication | Stage | Partner |
|---|---|---|---|---|---|
| 1. | Binimetinib | BRAF / MEK | Cancer | Approved | |
| 2. | Encorafenib | BRAF | Cancer | Phase 3 | Ono, Pierre Fabre |
| 3. | Selumetinib | MEK | Cancer | NDA filed | Astra Zeneca |
| 4. | Danoprevir | NS3 Protease | Hepatitis C | Approved | Roche |
| 5. | Larotrectinib | Trk family | Cancer | Approved | Bayer AG |
| 6. | Ipatasertib | AKT | Cancer | Phase 3 | Genentech |
| 7. | Varlitinib | Pan-HER | Cancer | Phase 3 | ASLAN |
| 8. | ARRY-797 | P-38 | LMNA-related DCM | Phase 3 | |
| 9. | ARRY-382 | CSF1R | Cancer | Phase 2 | |
| 10. | Larotrectinib | PanTrk | Cancer | Phase 2 | Loxo Oncology |
| 11. | Tucatinib | HER-2 | Cancer | Phase 2 | Seattle Genetics |
| 12. | Motolimod | TLR | Cancer | Phase 2 | Celgene |
| 13. | Prexasertib | Chk-1 | Cancer | Phase 2 | Eli Lilly |
| 14. | GDC-0575 | Chk-1 | Cancer | Phase 1 | Genentech |
| 15. | LOXO-292 | Ret | Cancer | Phase 1 | Bayer AG |
| 16. | LOXO-195 | Trk | Cancer | Phase 1 | Bayer AG |
| 17. | AK-1830 | Trk | Cancer | Phase I | Asahi kasei |
| 18. | MRTX849 | KRAS G12c | Cancer | Phase I | Mirati Therapeutics |

Source: Author compilation from https://www.arraybiopharma.com/

*B. The Collaboration with Astrazeneca*

MEK (Sr. No. 3) was a novel target in early 2000's and Array Biopharma successfully identified oral small molecule drug that could inhibit MEK. The MEK discovery program designated ARRY-142886 as the lead candidate. Astrazeneca licensed selumetinib from Array Biopharma in 2003 [11].

Astrazeneca was a large pharmaceutical company headquartered in United Kingdom. Astrazeneca as a company was focused on developing novel drugs for treatment of Oncology, Cardiovascular and Metabolic Diseases and Respiratory diseases. The deal included an upfront payment of USD 10 Mn for worldwide rights to the MEK program in the field of oncology, including

ARRY-142886 which later was named as selumetinib. The deal also included research funding and potential development milestones of over USD 85 Mn. Array was responsible for filing the IND and conducting the Phase I clinical trials. As per the agreement, Astrazeneca was responsible for further clinical development and commercialization. On successful commercialization Astrazeneca was to pay royalties of 12 percent to Array Biopharma [12].

*C. The Clinical Development of selumetinib*

Since then the Astrazeneca and Array collaboration conducted several clinical trials with ARRY-142886 or selumetinib or AZD6244 [13].

A Phase I Open-Label Multi-center was conducted by Array Pharma to study the Safety, Tolerability and Pharmacokinetics of AZD6244 (ARRY-142886) in breast cancer and colon cancer patients. This was followed by another phase 1 study in Inoperable Locally Advanced or Metastatic Biliary Tract Cancer patients [14]. A SUMIT trial was conducted in Metastatic Uveal Melanoma patients. The companies then conducted a trial in solid tumour patients to access the effect of food on pharmacokinetics of Selumetinib. Another study to access the effect of single oral dose of Selumetinib on QTc interval in Healthy Male Volunteers was also conducted in solid tumour patients [15]. A trial was conducted to study Solid Oral Dosage Formulation in Patients with Advanced Solid Malignancies. A study evaluating Absorption, Distribution, Metabolism and Excretion (ADME) of Single Dose [14C] Selumetinib in Volunteers was also conducted.

Then the companies studied several drugs in combination with Selumetinib in various cancer conditions. A Study of Selumetinib (AZD6244)(ARRY-142886) in Combination With Irinotecan in Previously Treated Patients With Colorectal cancer patients was conducted [16]. This was followed by a study to assess the effect of Rifampicin on the pharmacokinetics of Selumetinib in Healthy Male Volunteers. Another study was conducted in Locally Advanced or Metastatic NSCL Cancer Stage IIIB IV patients to access the safety and efficacy of the drug when given in Combination with Standard First Line Treatment for Advanced Non-small Cell Lung Cancer. Another study was conducted to study the effect of combination with Docetaxel in this patient population. A separate study was conducted to study the combination with Docetaxel in Patients receiving 2nd Line Treatment for v-Ki-ras 2 Kirsten Rat Sarcoma Viral Oncogene Homolog (KRAS) Positive NSCLC [17].

The companies then studied the effect of the drug in Differentiated Thyroid Cancer patients, Metastatic Colorectal Cancer and Uveal Melanoma cancer patients. A study to assess the Pharmacokinetics, Safety and Tolerability of Selumetinib in Renal Impaired Subjects and Healthy Subjects was conducted.

The companies then studied the drug in Non-small Cell Lung Cancer patients and compared it with Pemetrexed (Alimta®) [18]. Another study was conducted in Pancreatic cancer patients which compared the drug versus Capecitabine (Xeloda®) in patients who had failed who have failed First Line Gemcitabine Therapy.

Having explored solid tumour, the companies then studied the effect of this drug in combination With Azacitidine in Chronic Myeloid Leukemia (CML) and Myelofibrosis conditions. A Randomised Study to compare the efficacy of AZD6244 vs TMZ was also conducted. Astrazeneca also combined this drug with its PARP inhibitor Olaparib and studied it in solid tumour patients. Another study was conducted in Thyroid cancer patients to study the reacquisition of Radioactive Iodine (RAI) Uptake of RAI-Refractory Metastatic Thyroid Cancers by Pretreatment with the Selective MEK Inhibitor AZD6244. Another drug AZD2014 was studied in combination With Selumetinib in Patients with Advanced Cancers.

Then the drug was studied in Neurofibromatosis Type 1 patients. Another trial of Selumetinib in Patients with Neurofibromatosis Type 2 Related Tumors was conducted which included patients with Vestibular Schwannoma and Meningioma. Astrazeneca further studied the intermittent dosing Of Selumetinib in Childhood NF1 Associated Tumours. Selumetinib was then studied for treating patients With Neurofibromatosis Type 1 and Plexiform Neurofibromas that cannot be removed by Surgery. A trial was conducted to study Selumetinib in treating Young Patients with Recurrent or Refractory Low Grade Glioma in patients with Low Grade Glioma, Neurofibromatosis Type 1, Recurrent Childhood Pilocytic Astrocytoma and Recurrent Childhood Visual Pathway Glioma.

Astrazeneca and Array also published extensively on selumetinib in peer-reviewed journals and had Key Opinion Leaders present data at international symposiums. A partial list of these data disclosures are provided in the table below.

**Table 2: Key Data presentations and publications on selumetinib.**

| Title | Journal/ Conferences | Reference |
|---|---|---|
| "A Phase I study of the MEK1/2 inhibitor selumetinib in combination with first-line chemotherapy regimens for NSCLC" | ESMO | [19] |
| "A Phase I Study of the MEK1 Inhibitor Selumetinib (AZD6244) Hydrogen Sulfate in Children with Neurofibromatosis Type 1 (NF1) and Inoperable Plexiform Neurofibromas (PNs)" | American Society of Clinical Oncology Meeting | [20] |
| "Phase II Study of Selumetinib vs Temozolomide in Patients with Advanced Uveal Melanoma (CTEP #8443)" | American Society of Clinical Oncology Annual Meeting | [21] |
| "Selumetinib in women with recurrent low-grade serous carcinoma of the ovary or peritoneum: an open-label, single-arm, phase II study" | The Lancet Oncology | [22] |

During May 2016, the USFDA granted Selumetinib an orphan drug designation for the adjuvant treatment of stage III/IV Differentiated Thyroid Cancer (DTC) in 2016 [23]. This was followed by a Phase III ASTRA trial studying selumetinib in differentiated thyroid cancer (DTC) following surgery and treatment with radioactive iodine.

**Astrazeneca collaboration with Merck:** On July 27, 2017, Astrazeneca and Merck established a strategic collaboration on Oncology [24]. The collaboration centred around Astrazeneca drugs – Lynparza, selumetinib and combinations with PD-L1/PD-1 drugs Astrazeneca's Imfinzi and Merck's Keytruda. As part of the deal Astrazeneca retained the manufacturing rights for Lynparza and selumetinib. Merck was to fund all clinical trials combining Keytruda with Lynparza and selumetinib. The deal included USD 1.6 bn in up-front payment from Merck to Astrazeneca and additional USD 750 Mn for certain license options. There was also USD 6.5 bn of payments linked to future regulatory and sales milestones.

On February 15 2018, Selumetinib was granted orphan drug designation by the USFDA for the treatment of treatment of neurofibromatosis type 1 (NF1) [25]. NF1 is a rare genetic disorder that affect one in 3,000 births. Dysregulations in RAS/RAF/MEK/ERK signalling can be caused due to mutations in NF1 gene, which may result in tumour growth, and selumetinib may potentially be explored in clinical trials for treating this condition. This announcement was made jointly by Astrazeneca and Merck. The orphan drug designation is given to a candidate that is being developed for indications that represent less than 200,000 people in the United States [26].

**Acquisition of Array Biopharma by Pfizer:** In June 2019, Pfizer announced that it was acquiring Array Biopharma for a total deal value of approximately USD 11.4 billion [27]. At the time of this acquisition, Array has been marketing BRAFTOVI® (encorafenib) capsules in combination with MEKTOVI® (binimetinib) tablets in the USA and in collaboration with its partners in other countries worldwide. Larotrectinib that Array had earlier partnered with Bayer AG was successfully approved in the USA. Another drug danoprevir that Array had partnered with Roche had been successfully approved in China. LOXO-292 that Array had partnered with Eli Lilly, ipatasertib that Array had partnered with Genentech, tucatinib that Array had partnered with Seattle Genetics was undergoing registration trials. Selumetinib that Array had partnered with Astrazeneca was undergoing late stage registration trials at the time of the acquisition by Pfizer. Pfizer though the acquisition of Array Biopharma would be eligible for milestones and royalties to be received from Astrazeneca, the licensee of selumetinib.

**New Drug Application (NDA) filing:** On November 14, 2019, Astrazeneca reported that the United States Food and Drug Administration (USFDA) had accepted the NDA submission of selumetinib in neurofibromatosis type 1 (NF1) indication [28].

**Discussions:** This case study shows the intensive product life cycle management that has to happen in the drug development for developing a drug for the marketplace. The MEK candidate was discovered at Array and licensed to Astrazeneca in the year 2003, and since then several clinical trials have been conducted in several indications to develop this candidate either alone or in combination with other anti-cancer agents. This case study also shows that the data of the candidate was published in several peer reviewed journals and presented at several international conferences by Key Opinion Leaders which led to several higher fold valuation of the asset when Selumetinib was again partnered with Merck by Astrazeneca in 2017. The NDA for Selemetinib was filed in 2019 for NF1 indication, almost 16 years after the molecule was licensed by Astrazeneca in the year 2003.Thus drug discovery and development is long and time consuming, and it requires significant commitment by companies to develop new therapies for unmet medical needs.

The analysis of the deal shows a vast change in valuation from a preclinical asset that was licensed by Astrazencea from Array biopharma, to a Phase III asset that was licensed by Merck from Astrazencea. When the candidate was in preclinical stage it was valued for USD 10 Mn in up-fronts, while the same asset in late stage Phase III was valued at USD 1.6 Bn in up-fronts. This case study shows that the importance of stage of development of the asset has an important role in the valuation of the asset.

Array biopharma continued the development of its other in-house discovered compounds in collaboration with several partners worldwide and this has led to approvals of larotrectinib and danoprevir by its partners Bayer AG and Roche respectively. LOXO-292, ipatasertib, tucatinib, Selumetinib that Array had partnered with Eli Lilly, Genetech, Seattle Genetics and Astrazeneca was undergoing registration trials. Separately Array had achieved the successful registration of BRAFTOVI® (encorafenib) capsules in combination with MEKTOVI® (binimetinib) tablets in the USA, and was marketing this drug in collaboration with several partners in other countries across the globe.

**Table 3: Change in valuation of Selumetinib at different stages by different partners.**

| Stage | Preclinical | Phase 3 |
|---|---|---|
| Year | 2003 | 2017 |
| Licensee | Astrazeneca | Merck |
| Licensing terms | $ 10 Mn upfronts<br>$ 85 Mn milestones<br>12% royalty on net sales | $ 1.6 Bn upfronts<br>$ 750 Mn license options<br>$ 6.5 Bn for regulatory and sales milestones |
| Source | (Array Biopharma, 2003) | (Astrazeneca, 2017) |

## IV. FINDINGS

- Intensive product lifecycle management is necessary for drug development for the marketplace and it increases the value of the asset.
- Publication of data in peer reviewed scientific and medical journals of the candidate drug in product life cycle process may lead to many fold higher valuation of the asset.
- Value of the asset may increase several fold as the drug candidates advances through different stages of product life cycle. Hence drug development stages play a very important role in asset valuation.
- Strategic partnerships help to mitigate risks in drug development and registration.
- Clinical and regulatory partnership strategy is useful for future product life cycle management in the pharmaceutical and biotechnology industry.

## V. CONCLUSION

Array biopharma is a case of a biotechnology company that was successful in discovering drugs for several indications targeting high unmet medical needs in cancer. As the drug discovery and development process is long, time consuming, expensive, has a high risk of failure and rewards, Array biopharma did strategic collaborations with several partners. These strategic collaborations with large pharmaceutical companies like Astrazeneca, Eli Lilly, Bayer AG, Roche etc, helped Array biopharma to advance several candidates through its pipeline. In the year 2019, Array Biopharma had achieved drug approvals for its in-house discovered drugs including BRAFTOVI® (encorafenib), larotrectinib and danoprevir. The strategic partnerships also helped propel many drugs including LOXO-292, ipatasertib, tucatinib, selumetinib into late stage registration trials. This strategic product life cycle management of its assets helped Array biopharma achieve a valuation of USD 11.4 billion during the acquisition by Pfizer. This enormous effort by Array biopharma has also helped develop several drugs targeting high unmet medical needs.

## VI. FUTURE SCOPE

The study has the following limitations. This study is focused on the strategy adopted by a biotech company in developing one of its assets. Although it adds to the knowledge base, there are several cases of product development by other biotech companies which needs to be studied in future to analyze their product development and life-cycle management strategies.

**Conflict of Interest.** The authors declare no conflict of interest. The views presented in this paper are those of the authors only and do not represent the views or opinions of the institutes to which they are affiliated.

## REFERENCES


[1]. DiMasi, J. A. (2001). Risks in new drug development: approval success rates for investigational drugs. *Clinical Pharmacology & Therapeutics*, *69*(5), 297-307.

[2]. Munos, B. (2009). Lessons from 60 years of pharmaceutical innovation. *Nature reviews Drug discovery*, *8*(12), 959-968.

[3]. Priya, N., & Shobana, G. (2019). Application of Machine Learning Models in Drug Discovery: A Review. *International Journal on Emerging Technologies.* Vol. *10*(3): 268-275.

[4]. Hay, M., & Thomas, D. (2014). Clinical development success rates for investigational drugs. *Nature Biotechnology*, *32*, 40-51.

[5]. GrondeTvd, Uyl-de Groot CA, Pieters, T. (2017) Addressing the challenge of high-pricedprescription drugs in the era of precision medicine:A systematic review of drug life cycles, therapeuticdrug markets and regulatory frameworks. *PLoS ONE*, *12*(8): e0182613. https://doi.org/10.1371/journal.pone.0182613

[6]. Thomas, B., Chugan, P. K., & Srivastava, D. (2016). Pharmaceutical Research and Licensing Deals in India. *Macro and Micro Dynamics for Empowering Trade, Industry and Society, Eds., Deepak Srivastava, Pawan K. Chugan, Nirmal C. Soni, Nikunj Patel and Excel India Publishers, New Delhi, for Institute of Management, Nirma University, Ahmedabad India*, 13-21.

[7]. Thomas, B., & Chugan, P. (2019). Determinants of Licensing Decisions: A Study of Pharmaceutical Industry. *Business, Economy and Environment: The New Normal", Eds. Shamik Shome, Parag Rijwani and Deepak Danak, Himalaya Publishing House Pvt. Ltd., Mumbai for Institute of Management, Nirma University, Ahmedabad*, 242-258.

[8]. Berger, J. (2016). How drug life-cycle management patent strategies may impact formulary management. *Am J Manag Care*, Suppl. *16*, 487-495.

[9]. Matthew Herper. (2012). The Truly Staggering Cost Of Inventing New Drugs. Retrieved from The Truly Staggering Cost Of Inventing New Drugs: https://www.forbes.com/sites/matthewherper/2012/02/10/the-truly-staggering-cost-of-inventing-new-drugs/#7ba056934a94 (accessed February 2019)

[10]. Array (2000).*CERTIFICATE OF INCORPORATION.* Retrieved from SEC.GOV: https://www.sec.gov/Archives/edgar/data/1100412/000103570400000723/d80204ex3-1.txt (accessed March 2018)

[11]. Array (2013). *Arraybiopharma.* Retrieved from Array: https://www.arraybiopharma.com/application/files/5115/3618/4621/PubAttachment595.pdf (accessed September 2019)

[12]. Array (2003). *Array BioPharma and AstraZeneca Announce Oncology Collaboration*. Retrieved from Array BioPharma: http://investor.arraybiopharma.com/phoenix.zhtml?c=123810&p=irol-newsArticle&ID=479322&highlight= (accessed August 2019)

[13]. Clinicaltrials.gov, (2018).*SELUMETINIB and AZD6244*. Retrieved from clinicaltrials: https://clinicaltrials.gov/ct2/results?cond=ARRY-142886+&term=&cntry=&state=&city=&dist.

[14]. Patel, P., Howgate, E., Martin, P., Carlile, D. J., Aarons, L., & Zhou, D. (2018). Population pharmacokinetics of the MEK inhibitor selumetinib and its active N-desmethyl metabolite: data from 10 Phase I trials. *British journal of clinical pharmacology*, *84*(1), 52-63.

[15]. Zhou, D., So, K., Dymond, A., Vik, T., Al-Huniti, N., Mariani, G., & Martin, P. (2016). Evaluation of the Effect of Selumetinib on Cardiac Repolarization: A Randomized, Placebo- and Positive-controlled Crossover QT/QTc Study in Healthy Subjects. *Clin Ther*, *38*(12), 2555-2566.
[16].Hochster, H., Uboha , N., Messersmith, W., Gold , P., ONeil, B., Cohen, D., and Lenz, H. (2015). Phase II study of selumetinib (AZD6244, ARRY-142886) plus irinotecan as second-line therapy in patients with K-RAS mutated colorectal cancer. *Cancer Chemother Pharmacol.*, *75*(1), 17-23.
[17]. Metro, G., Chiari, R., Baldi, A., De Angelis, V., Minotti, V., and Crinò, L. (2013). Selumetinib: a promising pharmacologic approach for KRAS-mutant advanced non-small-cell lung cancer. *Future Oncol.*, *9*(2), 167-77.
[18]. Hainsworth, J. D., Cebotaru, C. L., Kanarev, V., Ciuleanu, T. E., Damyanov, D., Stella, P., ... & Tzekova, V. (2010). A Phase II, open-label, randomized study to assess the efficacy and safety of AZD6244 (ARRY-142886) versus pemetrexed in patients with non-small cell lung cancer who have failed one or two prior chemotherapeutic regimens. *Journal of Thoracic Oncology*, *5*(10), 1630-1636.
[19]. Dean, E., Steele, N., Arkenau, H., Blackhall, F., Haris, N., Lindsay, C., and Plummer, R. (2014). *ESMO.* Retrieved from oncologypro: https://oncologypro.esmo.org/Meeting-Resources/ESMO-2014/A-Phase-I-study-of-the-MEK1-2-inhibitor-selumetinib-in-combination-with-first-line-chemotherapy-regimens-for-NSCLC.
[20]. Widemann, B., Marcus, L., Fisher, M., Weiss, B., Kim, A., Baldwin, A., & Doyle, A. (2014). Phase I study of the MEK1/2 inhibitor selumetinib (AZD6244) hydrogen sulfate in children and young adults with neurofibromatosis type 1 (NF1) and inoperable plexiform neurofibromas (PNs). *Journal of Clinical Oncology*, *32*(15), 10018-10018.
[21]. Array ASCO. (2013). Retrieved from American Society of Clinical Oncology Annual Meeting: https://www.arraybiopharma.com/application/files/6715/3738/1153/PubAttachment572.pdf.
[22]. Farley, J., Brady, W. E., Vathipadiekal, V., Lankes, HA., Coleman, R., Morgan, M. A., Mannel, R., Yamada, SD., Mutch, D., Rodgers, WH., Birrer, M. & Gershenson DM. (2013). Selumetinib in women with recurrent low-grade serous carcinoma of the ovary or peritoneum: an open-label, single-arm, Phase II study. *Lancet Oncol., 14*(2),134-140.
[23]. Astrazeneca (2016) *Selumetinib granted Orphan Drug Designation in the US for adjuvant treatment of differentiated thyroid cancer*. Retrieved from Astrazeneca: https://www.astrazeneca.com/media-centre/press-releases/2016/selumetinib-granted-orphan-drug-designation-in-the-US-for-adjuvant-treatment-of-differentiated-thyroid-cancer-12052016.html.
[24]. Astrazeneca (2017). *AstraZeneca and Merck establish strategic oncology collaboration*. Retrieved from AstraZeneca and Merck establish strategic oncology collaboration: https://www.astrazeneca.com/media-centre/press-releases/2017/astrazeneca-and-merck-establish-strategic-oncology-collaboration-27072017.html.
[25]. Astrazeneca (2018) *Selumetinib granted Orphan Drug Designation by the US FDA for neurofibromatosis type 1*. Retrieved from Astrazeneca: https://www.astrazeneca.com/media-centre/press-releases/2018/selumetinib-granted-orphan-drug-designation-by-the-us-fda-for-neurofibromatosis-type-1-15022018.html
[26]. Businesswire (2018) *Selumetinib Granted Orphan Drug Designation by U.S.FDA*. Retrieved from Businesswire: https://www.businesswire.com/news/home/20180215005529/en/Selumetinib-Granted-Orphan-Drug-Designation-U.S.-FDA
[27]. Pfizer. (2019). *PFIZER TO ACQUIRE ARRAY BIOPHARMA*. Retrieved from Pfizer: https://www.pfizer.com/news/press-release/press-release-detail/pfizer_to_acquire_array_biopharma .
[28]. Astrazeneca (2019). *US FDA accepts regulatory submission for selumetinib in neurofibromatosis type 1 and grants Priority Review.* Retrieved from Astrazeneca: https://www.astrazeneca.com/media-centre/press-releases/2019/us-fda-accepts-regulatory-submission-for-selumetinib-in-neurofibromatosis-type-1-and-grants-priority-review-14112019.html

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