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Our understanding of how molecularly targeted anticancer compounds affect tumor cell proliferation has been hindered by lack of models that take into account multiple cell fates, such as continued cell division, death or entry into a non-dividing state (e.g. quiescence or senescence). We have developed an approach that leverages time lapse automated fluorescence microscopy to track individual cells, determine their fates, and estimate the rates of cell division, death and entry into quiescence that, in aggregate, form the overall proliferation rate of a population of cells. A mathematical model—the Quiescence Growth model—was derived from a simple exponential growth model (the dividing cell compartment) to include a rate of entry into a non-dividing state (e.g. quiescence) and death. This approach allows the accurate determination of the effects of drugs on each of these rates that comprise the overall antiproliferative response. We demonstrate the utility of this approach using erlotinib-treated lung cancer cells.

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