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## **Analytic Solution for Ratchet Guaranteed Minimum Death Benefit Options Under a Variety of Mortality Laws**

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We derive a number of analytic results for GMDB ratchet options. Closed form solutions are found for DeMoivre's Law, Constant Force of Mortality, Constant Force of Mortality with an endowment age and constant force of mortality with a cutoff age. We find an infinite series solution for a general mortality laws and we derive the conditions under which this series terminates. We sum this series for at-the-money options under Makeham's Law of Mortality which provides a realistic approximation for human mortality in many circumstances.