Analysis of Odds in the Three-Way Duel

Suppose you are in a two-way duel with Cowboy 3. Your odds of survival are 0 if he goes first and 1/3 if you go first.

Suppose you are in a two-way duel with Cowboy 2 where you go first. Your odds of hitting him on your first turn are 1/3. Your odds of hitting him on your second turn are the odds of missing him on your first, times the odds of having him miss on his first, times the odds of hitting him on your second, or (2/3)(1/3)(1/3). Similarly, your odds of hitting him on your third turn are (2/3)(1/3)(2/3)(1/3)(1/3), etc. This gives rise to the series $(1/3)\sum_{i=0}^{\infty}((2/3)(1/3))^i$. When $r < 1.0$, $\sum_{i=0}^{\infty} = 1/(1-1/r)$, so this summation on your odds of survival comes out to $(1/3)1/(1-2/9) = 3/7$. Let's keep this result in mind.

If Cowboy 2 goes first, there is only a 1/3 chance that he will miss his first turn. If he does, then what remains of the contest is a duel where you go first, so your overall odds are only $(1/3)(3/7) = 1/7$.

Let's now look at the three-way duel. If you hit Cowboy 3, what remains is a duel with Cowboy 2 where he goes first, so your odds of survival are therefore 1/7 if you hit Cowboy 3. They are 0 if you hit Cowboy 2. The best you can do by hitting anybody is 1/7.

If you shoot up in the air, then if Cowboy 3 survives the first round, it is a two-way duel where you go first and your odds of surviving are 1/3. Multiplying this by Cowboy 3's 1/3 chance of surviving the first round gives a 1/9 probability that you will survive by finishing off Cowboy 3. Similarly, there is a 2/3 probability that Cowboy 2 will survive the first round and what follows is a duel between you and him where you go first, for a total of $(2/3)(3/7) = 2/7$.

The total for your chance of survival by shooting in the air on round 1 is $2/7 + 1/9 = 25/63$. Shooting another cowboy reduces your odds by a factor of about 2 3/4.