A Continuous Life-years Gained Priority Score for Ventilator Allocation

Theory

Military triage- save as many soldiers as possible

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3. Rank order patients who will die without critical care by $P(ICUSurvival)$ (Red $>$ Yellow)
4. Treat as many patients as possible in order of $P(ICUSurvival)$

Problems with military triage approach in the COVID-19 Pandemic

Three patients with COVID-19

28 year old female
- SOFA: 30% survival

80 year old male
- SOFA: 75% survival

60 year old male
- SOFA: 50% survival

Who gets the one remaining ventilator?

New York ventilator allocation policy

Priority rankings under NY triage system

3

28 year old female
- 30% survival

1

80 year old male
- 75% survival

2

60 year old male
- 50% survival

Goes against "youngest first" allocation principles.

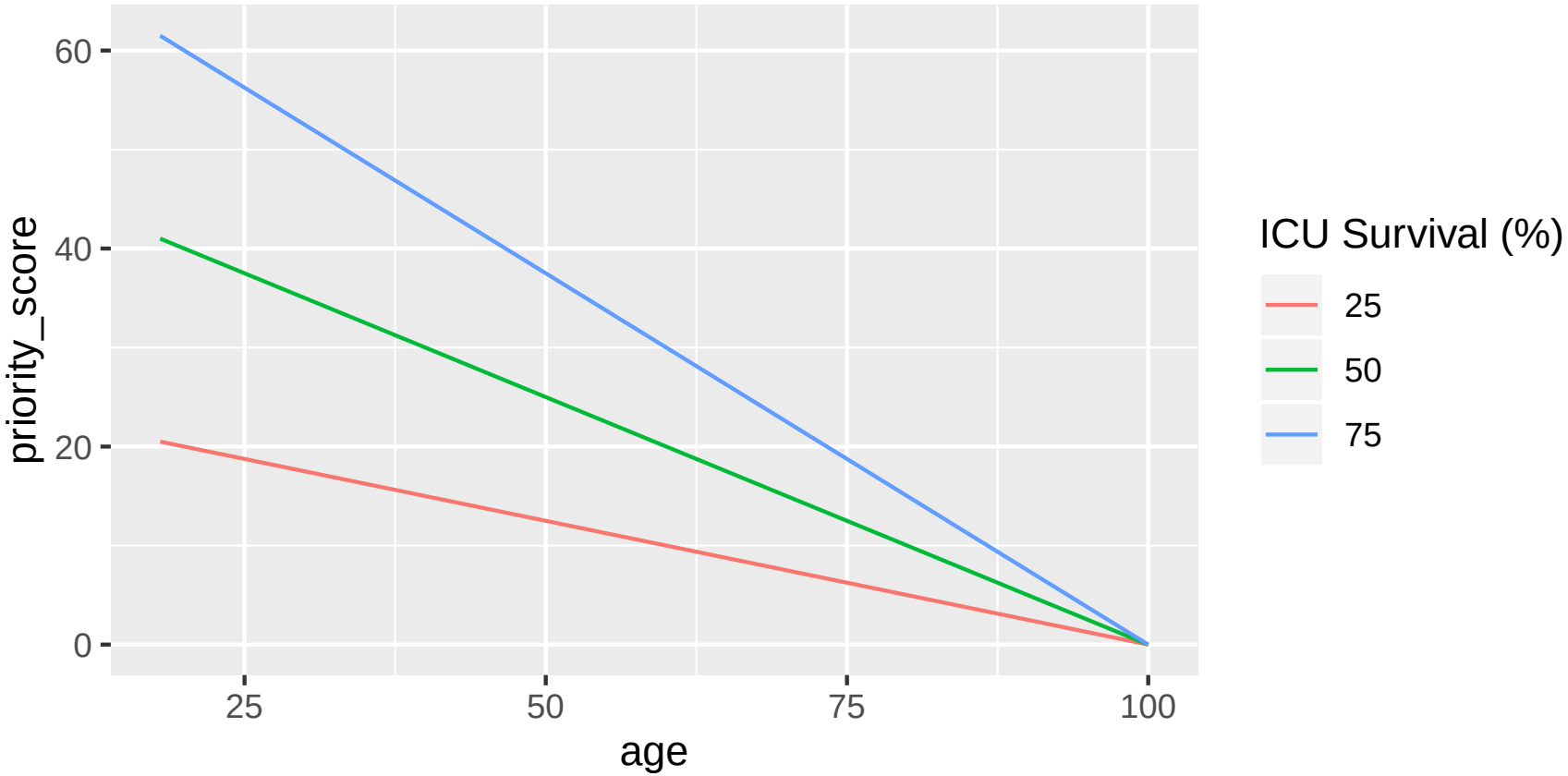
Maximizing life-years gained

An alternative **utilitarian** approach is to maximize life-years gained

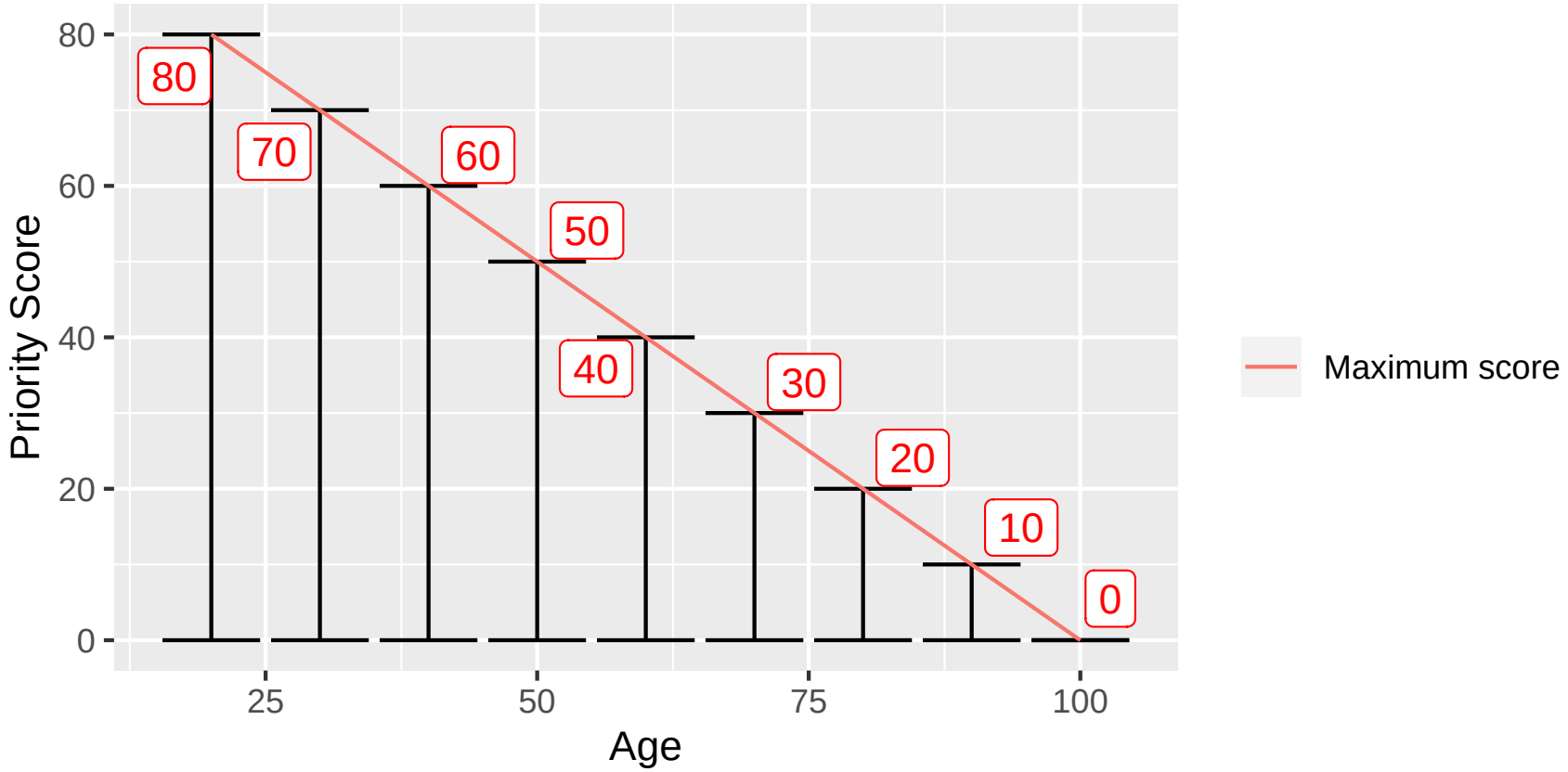
Priority Score that maximizes life-years gained

$$PriorityScore = P(ICUSurvival) * (100 - age)$$

Priority Score vs. Patient Age, by Probability of ICU Survival



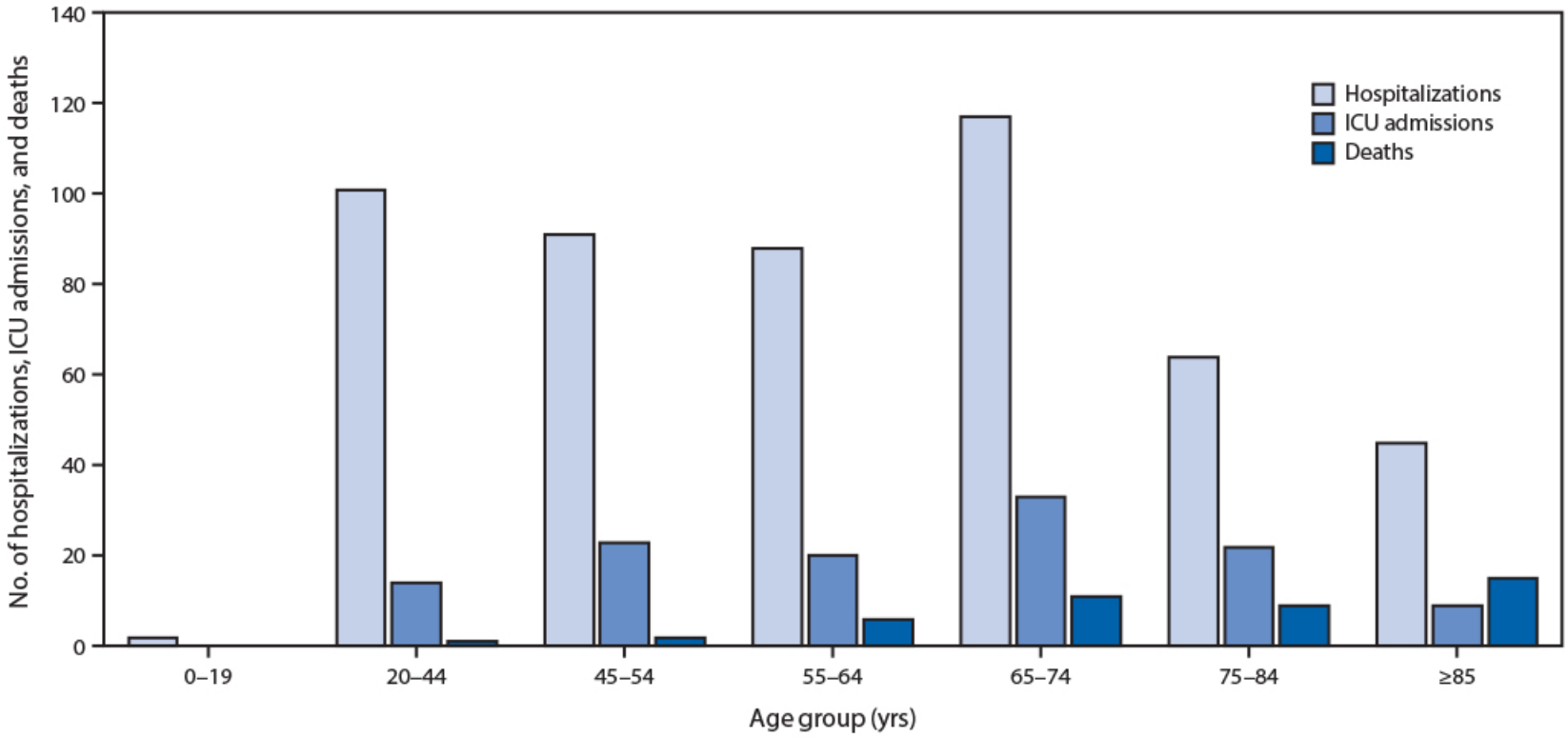
Range of possible priority scores by patient age



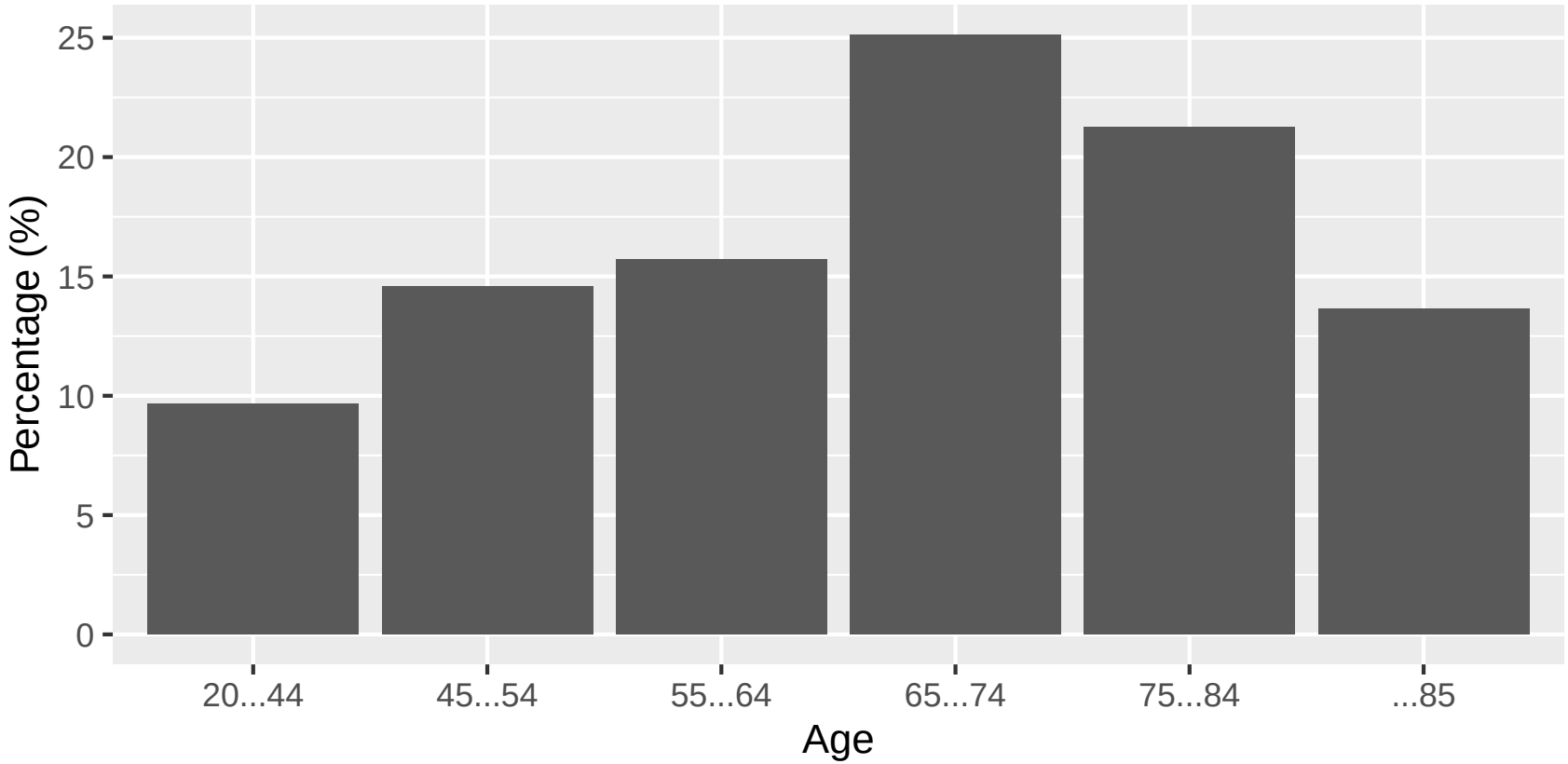
Simulation using CDC data

Data source

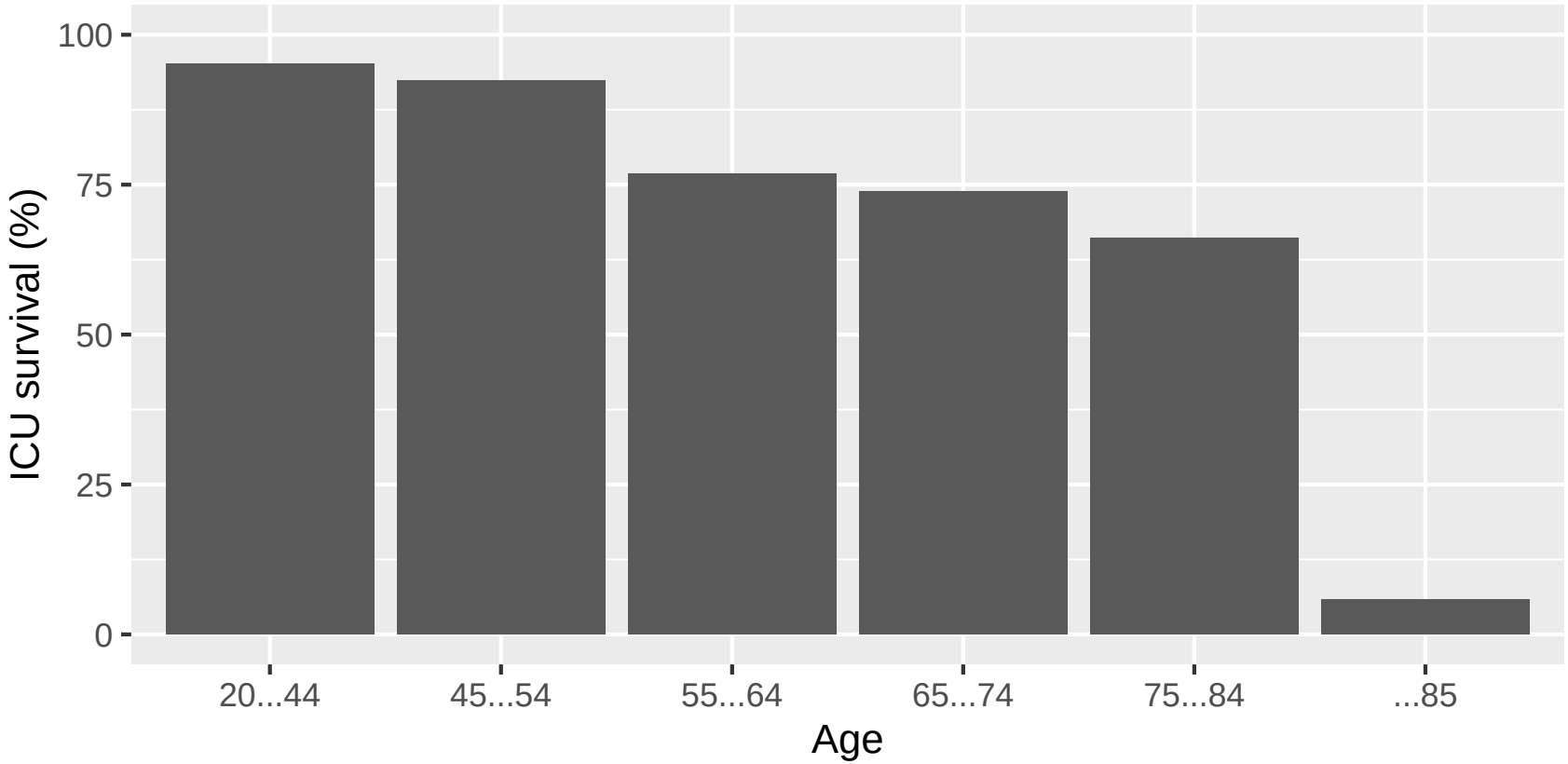
We took data from the CDC report Severe Outcomes Among Patients with Coronavirus Disease 2019 — United States, February 12–March 16, 2020



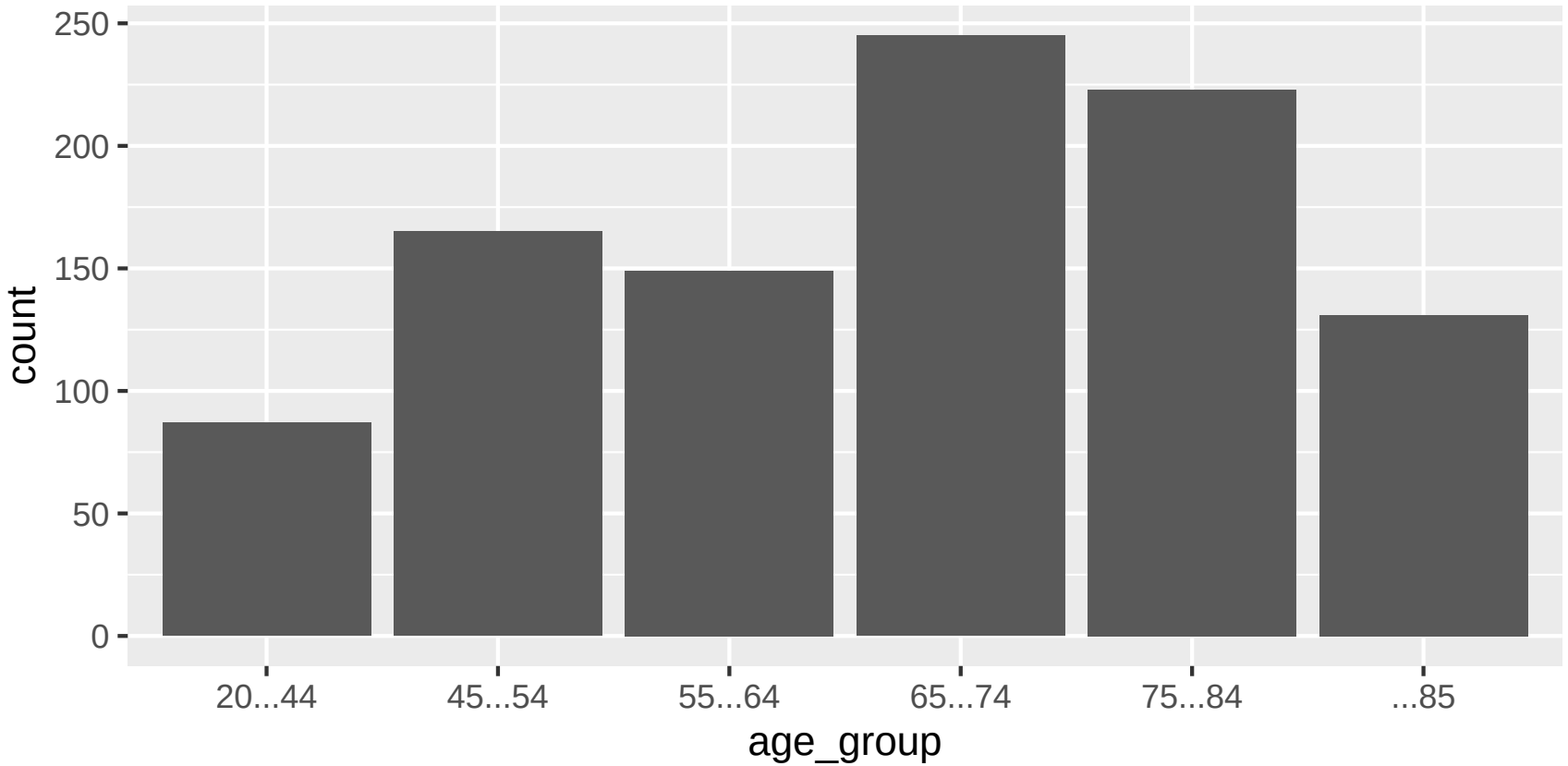
COVID-19 Age Distribution of patients requiring ICU



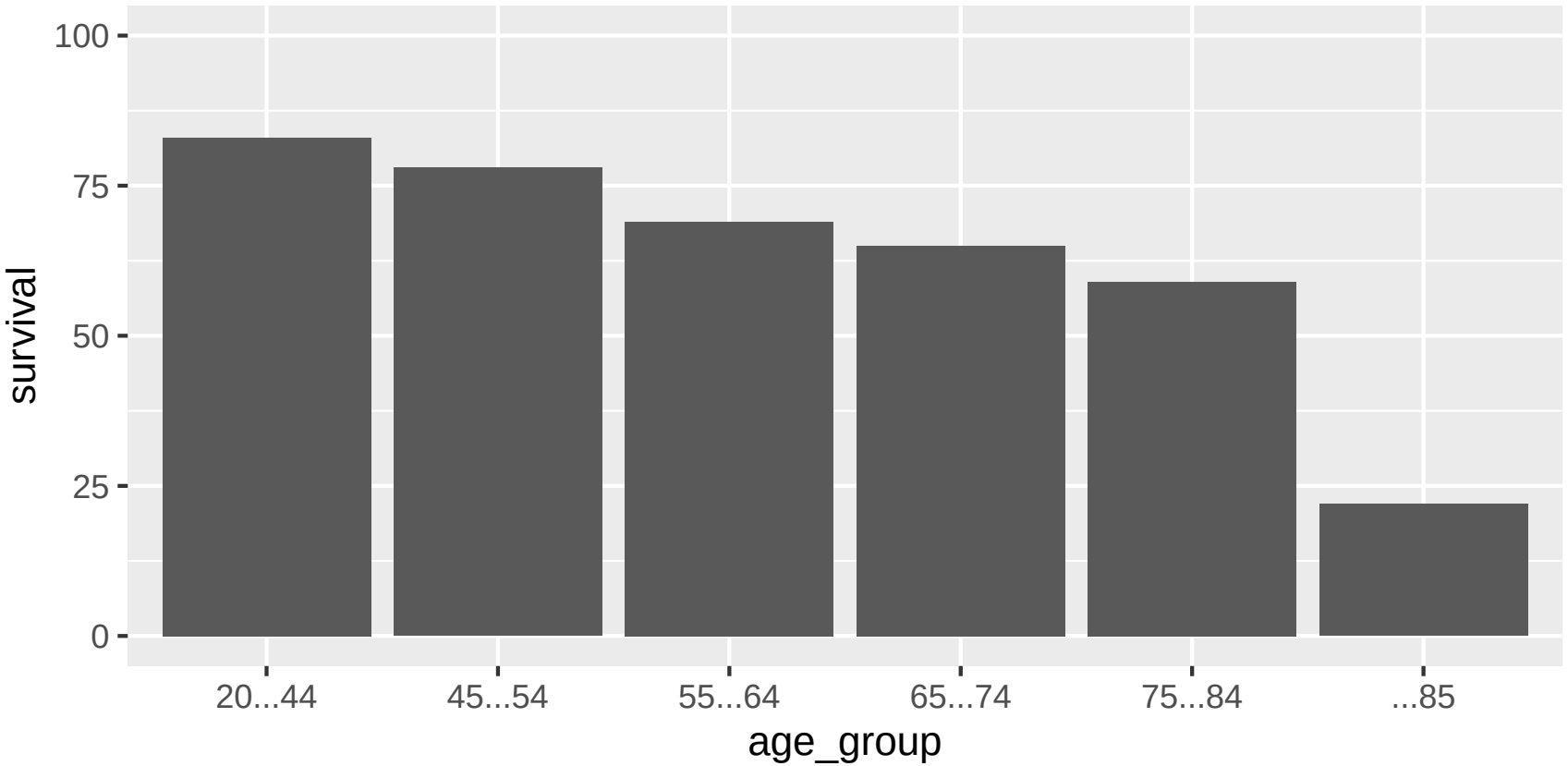
COVID-19 ICU survival by Age in the US per the CDC



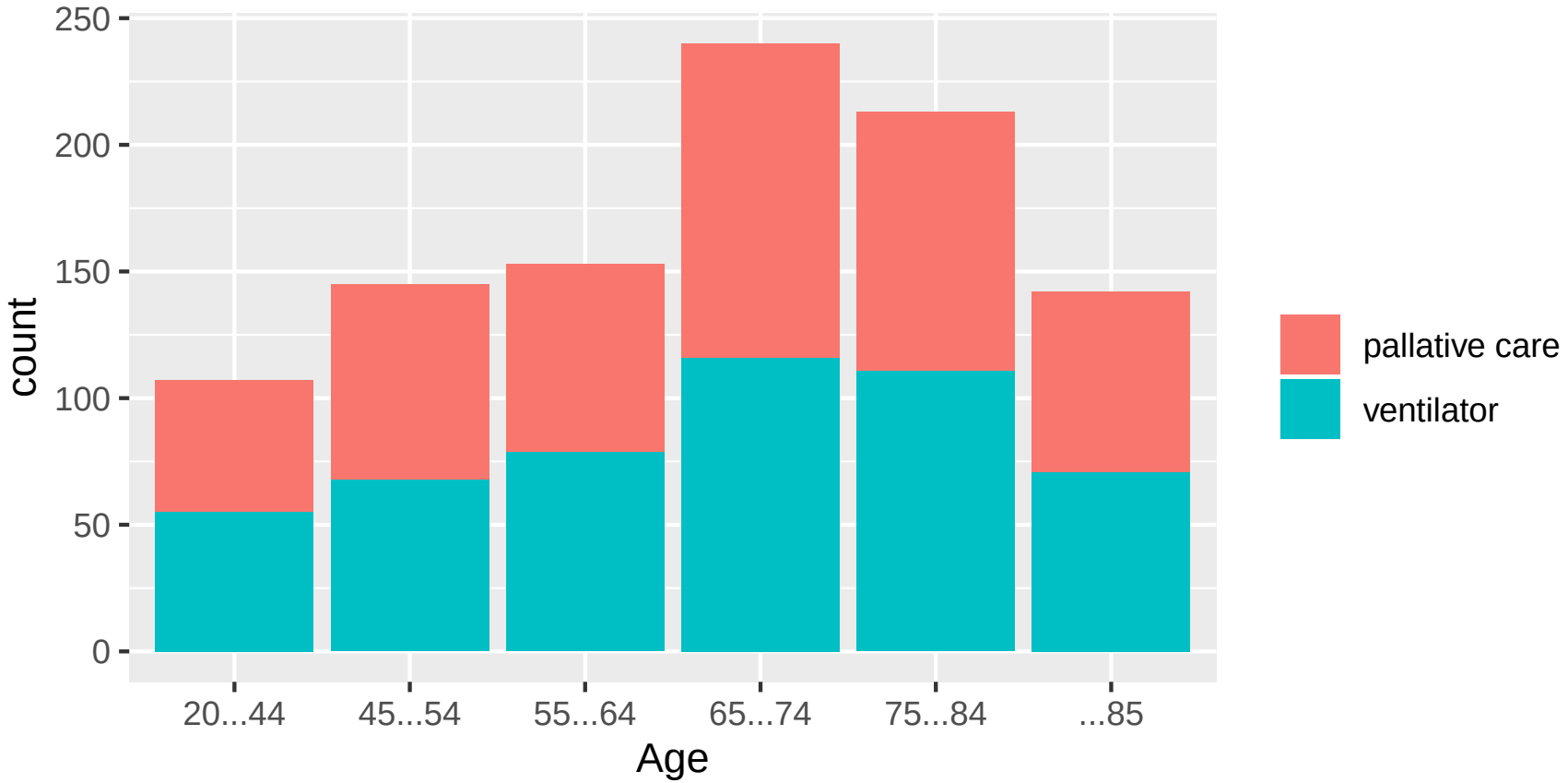
Simulated ICU population



Simulated Survival by Age

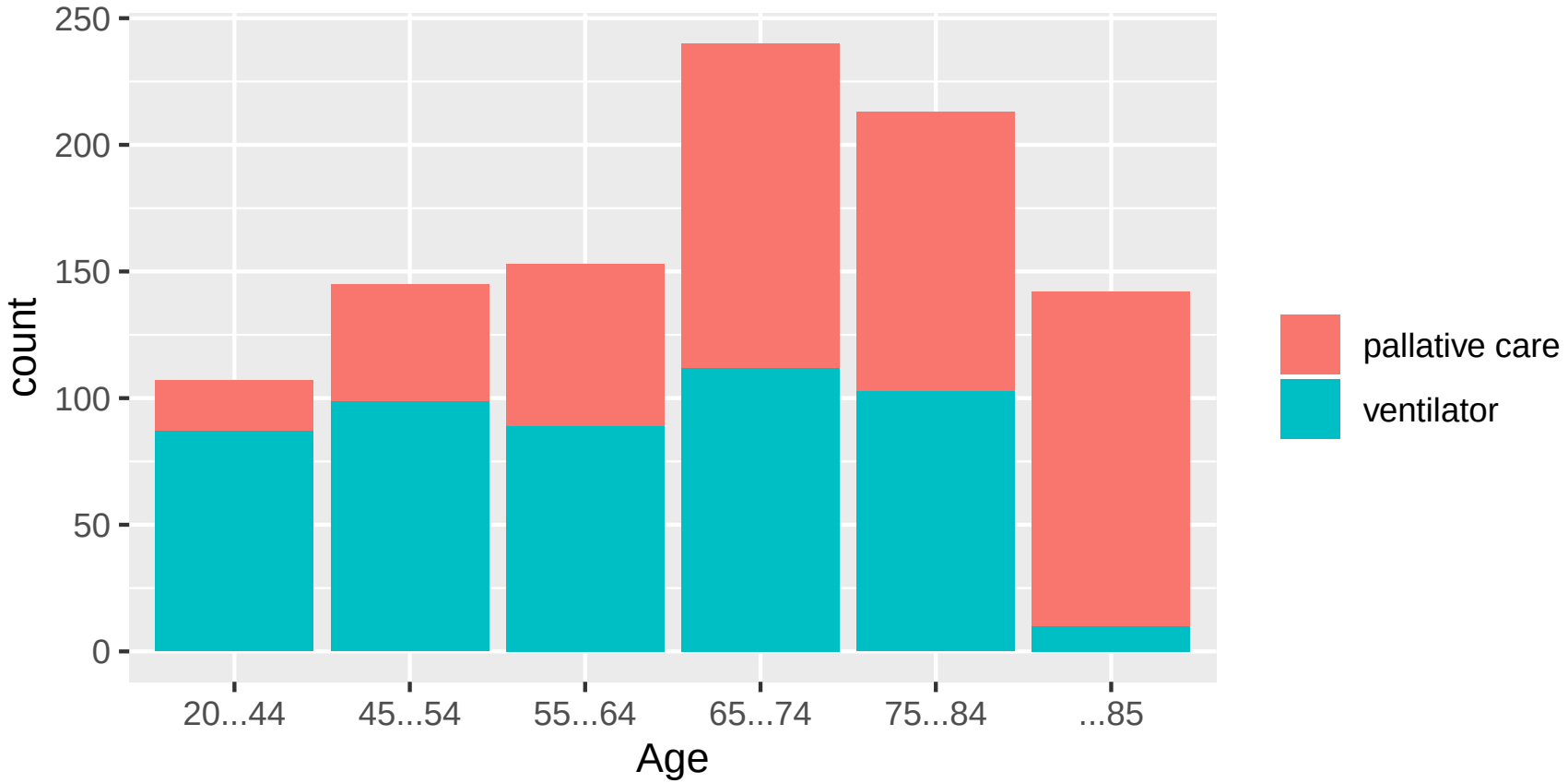


Lottery allocation



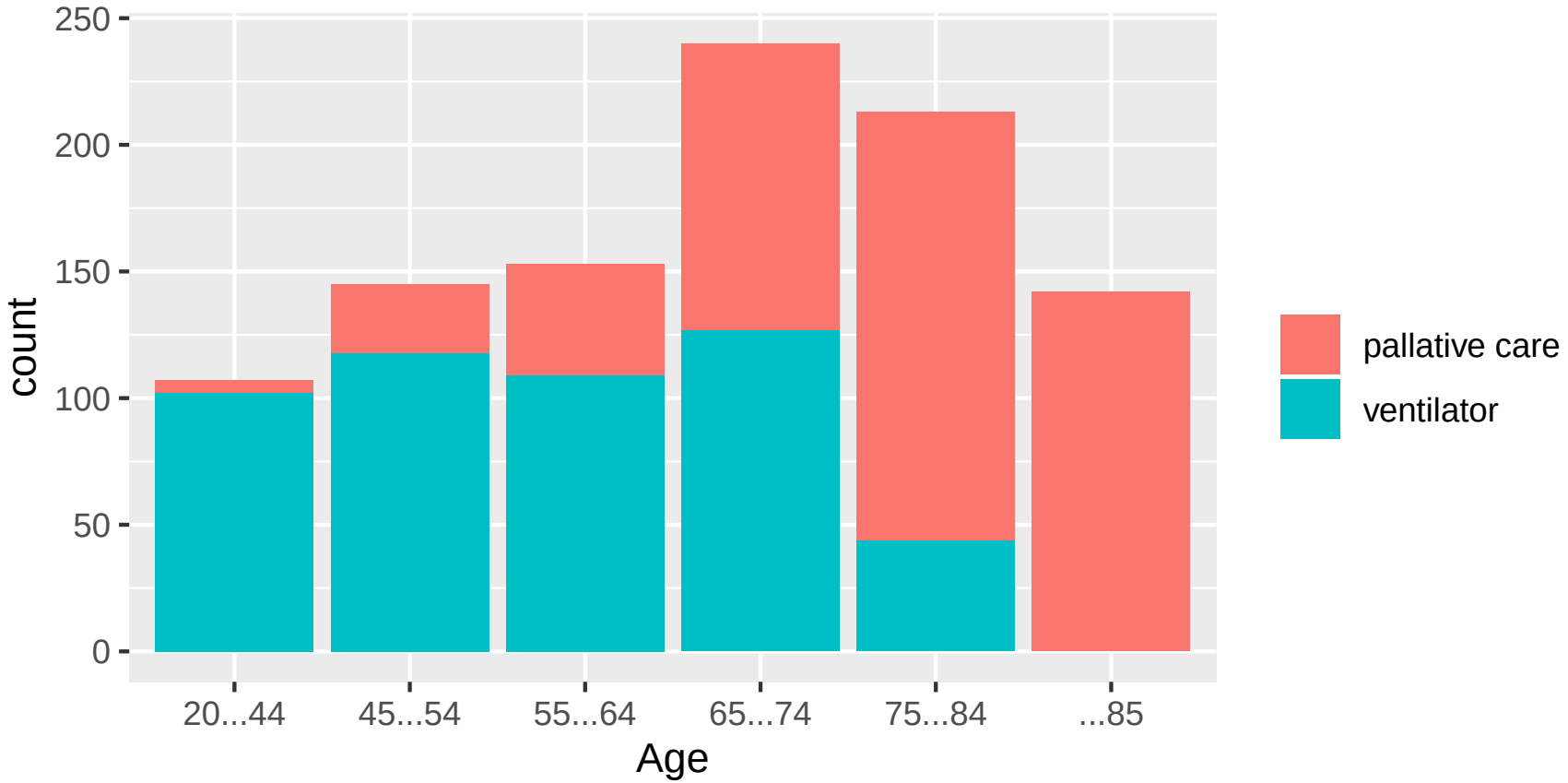
Random assigment of vents, ignoring age and $P(ICUsurvival)$. A lottery allocation of 500 ventilators would save 319 out of 1000 patients admitted to the ICU. A lottery saves 12,146 out of a total

Maximizing ICU survival



A ICU survival triage system of 500 ventilators would save 466 out of 1000 patients admitted to the ICU. Maximizing ICU survival saves 18,856 out of a total of possible 33,927 (56%).

Maximizing Life-years gained



Prioritizing life-years for 500 ventilators would save 448 out of 1000 patients admitted to the ICU. Maximizing life-years gained saves 19,679 out of a total of possible 33,927 (58%).

Maximizing life-years vs. ICU survival

The Tradeoff

Prioritizing life-years gained over ICU survival saves an additional 823 life-years for this 1000 patient sample, at a cost of 18 more deaths in the ICU.