An MCDA approach to identify direct relationships between health states in Markov chains for heart failure treatments

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Objective

To identify direct relationships between health states in two Markov chains for heart failure treatments. After that, this study seeks to observe if the identified direct relationships between health states for the studied treatments are the same.

Methods

The Markov chains generated by Thokala et al. (2020)[1] to evaluate the use of telemonitoring versus usual care as treatments for heart failure were used to identify direct relationships between the following health states: stable disease; severity degree #1; severity degree #2; severity degree #3; and death (Table 1A and Table 1B).

The Weighted Influence Non-linear Gauge System (WINGS) multi-criteria decision analysis (MCDA) approach[2] was applied in the telemonitoring and usual care Markov chains separately.

To apply WINGS:

1. Each health state in a chain was considered as an element in a system.
2. The probability to remain in a health state in a chain was considered as the strength degree of each element in a system.
3. The probability transition from a health state to another in a chain was considered as the influence degree that an element exerts over another in a system.

The analogy between WINGS and Markov chains cited above is demonstrated in Figure 1.

Table 1A: Monthly transition matrix for usual care.

Health state	Stable disease	Severity degree #1	Severity degree #2	Severity degree #3	Death
Stable disease	0.981	0.004	0.000	0.000	0.015
Severity degree #1	0.068	0.872	0.017	0.000	0.043
Severity degree #2	0.004	0.094	0.777	0.041	0.084
Severity degree #3	0.000	0.006	0.095	0.777	0.122
Death	0.000	0.000	0.000	0.000	1.000

Source: Thokala et al. (2020)[1]

Table 1B: Monthly transition matrix for telemonitoring.

Health state	Stable disease	Severity degree #1	Severity degree #2	Severity degree #3	Death
Stable disease	0.986	0.003	0.000	0.000	0.011
Severity degree #1	0.068	0.885	0.013	0.000	0.033
Severity degree #2	0.004	0.096	0.804	0.032	0.065
Severity degree #3	0.000	0.006	0.098	0.801	0.094
Death	0.000	0.000	0.000	0.000	1.000

Source: Thokala et al. (2020)[1]

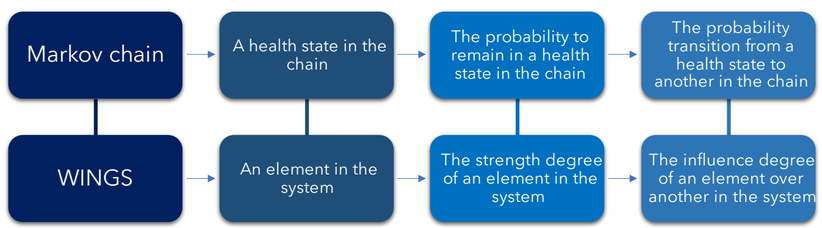

Figure 1: Analogy between the WINGS method and Markov chains.

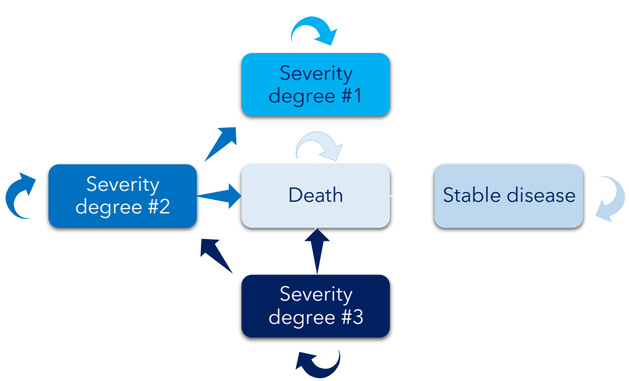

Figure 2A: Direct relationships between health states identified for usual care.

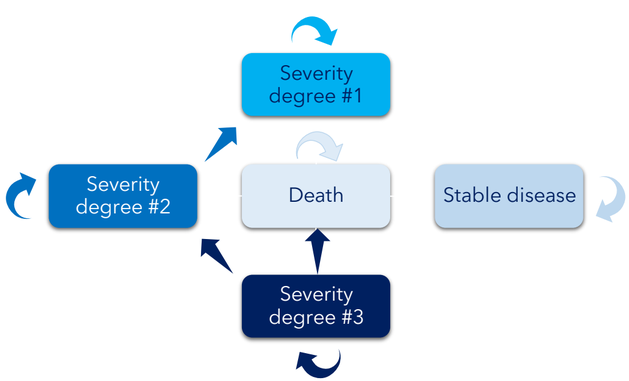

Figure 2B: Direct relationships between health states identified for telemonitoring.

Results

WINGS identified the following eight direct relationships in both chains:

1. Remain in stable disease;
2. Remain in severity degree #1.
3. Remain in severity degree #2.
4. Remain in severity degree #3.
5. Remain in death.
6. From severity degree #2 to severity degree #1.
7. From severity degree #3 to severity degree #2;
8. From severity degree #3 to death.

In addition, the direct relationship from severity degree #2 to death was identified only for usual care.

The usual care and telemonitoring Markov chains with their direct relationships between health states are presented in Figure 2A and Figure 2B, respectively.

Conclusion

The MCDA approach here presented showed a way to identify direct relationships between health states in Markov chains. Thus, it was possible to note that there is a direct relationship from severity degree #2 to death only in the usual care Markov chain.

References

1. Thokala P, Dodd P, Baalbaki H, Brennan A, Dixon S, Lowrie K. Developing Markov models from real-world data: A case study of heart failure modeling using administrative data. Value Heal. 2020;23(6):743–50.

2. Michnik J. Weighted Influence Non-linear Gauge System (WINGS) – An analysis method for the systems of interrelated components. Eur J Oper Res. 2013;228(3):536–44.