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BRIEF REPORT

Prostate Cancer Patients Gradually Advance Goals for Rehabilitation After Radical Prostatectomy: Applying a Lines-of-Defense Model to Rehabilitation

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Following tumor surgery, urinary incontinence challenges prostate cancer patients' functional health. Adjustments of functional goals (lines of defense [LoDs]) were examined during rehabilitation from incontinence. A conceptual model proposing stepwise and distinct upward adjustments of LoDs, ranging from minimizing discomfort (lowest LoD) to protecting self-reliance (highest LoD), was investigated. Within 7 months following the onset of incontinence, 175 patients completed questionnaires at 4 occasions. A theory-based hierarchy was imposed on time-invariant latent classes of LoD-endorsements. As incontinence receded, patients transitioned upward through the hierarchy of LoD-classes, matched LoDs to concurrent incontinence levels, and thus promptly claimed independent functioning with physical improvements.

Keywords: lines of defense, rehabilitation, prostate cancer, urinary incontinence

Urinary incontinence following the surgical removal of the prostate (i.e., radical prostatectomy, RP) typically places constraints on prostate cancer patients' independence that recede again when continence is recovered (Boorjian et al., 2012; Knoll, Burkert, Roigas, & Gralla, 2011; Resendes & McCorkle, 2006). Under these circumstances, investing rehabilitative effort for the right goals, neither overaspiring nor foregoing one's potential for a speedy and complete recovery, can be challenging.

The recent lines-of-defense (LoDs) model (Heckhausen, 2005; Heckhausen, Wrosch, & Schulz, 2013) complements predictions from the motivational theory of life span development (MLD; Heckhausen, Wrosch, & Schulz, 2010) for optimized choice of functional goals in the context of adaptation to changing health and associated functioning. These goals for functioning, referred to as LoDs, are assumed to be hierarchically organized and chosen in accordance with the indi-

viduals' health-related control capacity. Control capacity refers to the "extent to which the individual realizes control over his or her environment (i.e., primary control) across different domains of life and across the life span" (Heckhausen et al., 2013, p. 35). A central tenet of the LoDs model holds that persons facing health-related changes in control capacity, including losses or gains in physical and/or mental functioning, will have to choose a viable goal, hold on to this goal, and only then let go of it when it is no longer feasible or when control capacity improves to an extent where new opportunities for primary control arise (e.g., Boerner, 2004; Brandtstädter & Rothermund, 2002; Ebner, Freund, & Baltes, 2006; Hall, Chipperfield, Heckhausen, & Perry, 2010; Heckhausen et al., 2013). Disengagement from one LoD and engagement with the next is proposed to happen in discrete shifts rather than gradual processes. A new and yet unstudied assumption of the LoDs model predicts ordered, sequential movement through a proposed hierarchy of LoDs (Heckhausen et al., 2013). In a version of the LoDs model adopted in the present research,¹ Heckhausen (2005)

¹ In a recently revised version of the LoDs model. Heckhausen et al.

proposed the following hierarchy of LoDs: When health is good, individuals will strive to (1) avoid disease or disability. Once disease develops and accompanying functional limitations are no longer avoidable, the (2) protection of self-reliance becomes the next LoD. If disease progresses and independence becomes severely challenged, the next adaptive LoD should be to (3) use aids and help to maintain functional ability. (4) Minimizing discomfort and finally (5) delaying death are assumed to be LoDs representing the lowest levels of the goal hierarchy, when health takes an (irreversible) downturn. Originally proposed to predict downward goal adjustments in the context of progressive chronic disease, Heckhausen, Wrosch, and Schulz (2013) propose that the LoDs model can also be applied to improving health and functioning during recovery and rehabilitation. Here, adjustments of LoDs should be reversed that is, upward adjustments toward more ambitious goals are expected as health improves and control capacity increases over time. In this study, prostate cancer patients' LoDs are investigated in the context of onset and subsequent recovery from postsurgical incontinence following radical prostatectomy (RP).

Although RP as one standard treatment of localized prostate cancer has excellent oncological results, following surgery most patients face postoperative functional limitations, including urinary incontinence (Boorjian et al., 2012). Reported rates of incontinence vary widely depending on definition, type and timing of assessment (Boorjian et al., 2012). For instance, Stanford et al. (2000) reported that at 6 months postsurgery, 67.9% of patients experienced varying degrees of incontinence. Severity and duration covary with patients' age, presurgery functions, or modes of RP (Boorjian et al., 2012; Prabhu, Sivarajan, Taksler, Laze, & Lepor, 2014), but are still hard to predict. Highest levels of incontinence occur at its onset following the removal of the postoperative catheter. It generally recedes within 1 year, with steeper rates of decline during the first 6 months (Prabhu et al., 2014). Incontinence coincides with worse affect and more use of support, typically from partners (Eton & Lepore, 2002; Knoll, Burkert, Scholz, Roigas, & Gralla, 2012). Support includes transport of sanitary pads, reminders for rehabilitative exercise, or performing errands (Resendes & McCorkle, 2006).

Predictions from the LoDs model (Heckhausen, 2005; Heckhausen et al., 2013) were investigated in the context of sudden onset and subsequent gradual recovery from urinary incontinence following RP. Accounting for the fact that following RP almost all patients cope with varying degrees of urinary incontinence, yet incontinence is not fatal, the original first (avoiding disease and disability) and fifth LoDs (delaying death; Heckhausen, 2005) were not addressed. Moreover, the original third LoD (use aids and help to maintain functional ability; Heckhausen, 2005) was divided into two goals (*with* and *without* accepting help from others, cf. Heckhausen et al., 2013). Thus, this study focused on the following set of LoDs, henceforth referred to as LoD1 through LoD4:

nal latent class approach was used to investigate patients' patterns or classes of LoD-endorsement and to determine their "movement" among classes over time. If measurement invariance over time can be assumed and if classes of LoD-endorsement resemble a hierarchical structure, transitions can be viewed as "upward" (i.e., toward more ambitious goals) or "downward" movement in choice of LoDs. The following hypotheses were tested: (H1) During rehabilitation from incontinence, patients are assumed to upwardly adjust their LoDs. Thus, within a hierarchical system of LoDclasses, more participants are expected to change LoD-classes in an upward direction (i.e., toward a class of LoDs dominated by protection of self-reliance) than in a downward direction (i.e., toward a class of LoDs characterized by minimizing discomfort by disengagement). (H2) Incontinence as an indicator of control capacity will be associated with class membership. Persons with less pronounced incontinence will more likely belong to a class characterized by protection of self-reliance. Persons with more severe incontinence will likely belong to a class that strives for minimizing discomfort by disengagement.

Method

Procedure and Sample

Data stem from a longitudinal project with couples managing postsurgery sequelae following RP. Inclusion criteria were patients' undergoing RP and living in a relationship with a heterosexual partner. Exclusion criteria were not giving informed consent, the partner's refusal to participate in the study, and insufficient comprehension of the German language. Couples received a compensation of 110 Euros for full participation. Following informed consent, the first questionnaire assessment (T0) took place upon admission to one of two departments of urology in a large metropolitan area in Germany, one day prior to surgery. Other measurements were completed via mail and scheduled at 1 month (T1), 3 (T2), 5 (T3), and 7 months (T4) following the onset of incontinence. The study procedure was approved by the Institutional Review Board. Patients' T1 to T4 data were included in this study.

Of 209 patients enrolled, 175 (83.73%) remained in the study following surgery and provided data at a minimum of one postsurgery occasion, 169 (80.86%) completed all assessments. Providing data at all points in time was uniquely associated with less patient-reported difficulties in performing activities of daily life and partners' vocational training. Patients' mean age was 63.53 years (SD = 6.74, range 46 to 77). Most were married (87.30%) and 89% had children. About half (51.50%) reported more than 10 years of schooling, the remainder reported 9 or 10 years of schoolPatients' urinary incontinence *during the past week* was measured by the German short form of the International Consultation of Incontinence Questionnaire (ICIQ-SF; Karantanis, Fynes, Moore, & Stanton, 2004). The ICIQ-SF's weighted sum score ranges from 0 to 21, with internal consistencies ranging from $\alpha = .75$ to .81. All items were assessed at all occasions.

Data Analyses

To assess the appropriate number of classes and movement throughout these classes of LoD endorsements, latent transition analyses with two to five classes incorporating either full noninvariance or full invariance were estimated (Graham, Collins, Wugalter, Chung, & Hansen, 1991; Kaplan, 2008). Full invariance refers to the case in which the conditional response probabilities were constrained to be equal over time (e.g., the probability of endorsing LoD1 is equal at all occasions within each class) while full noninvariance imposes no restrictions (Nylund, 2007). Models of 500 different sets of starting values were estimated. The Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), and the sample-size adjusted Bayesian Information Criterion (aBIC) were used jointly to identify the best model, because there is no consensus about which information criterion is best suited to determine the appropriate number of classes. To determine interrelations between class membership and incontinence, latent classes found in the longitudinal model were analyzed separately for each time point using the three-step maximum likelihood approach suggested by Vermunt (2010). Simultaneous analysis of all four postoperative measurement occasions did not seem feasible, because of an unfavorable relation between free parameters and sample size. The third step of this approach was a latent multinomial logistic regression with 5,000 bootstrap samples drawn to test statistical significance of regression weights. A full information maximum likelihood approach was used to account for missing data (Enders, 2010). The above described analyses were performed using Mplus 6.1 (Muthén & Muthén, 1998-2012) and R Version 3.0.1 (R Development Core Team, 2012). SPSS 22.0 was used for correlations and logistic regression for drop-out analyses and for one repeated-measures ANOVA.

Results

At 1 month after its onset (T1), 92.4% of patients experienced some extent of urinary incontinence. Over the course of the 7-month rehabilitation phase, incontinence decreased significantly (ICQ-SF; TIME F(3, 522) = 94.49, p < .001). However, at T4 still 76.2% of patients noted episodes of incontinence at least once a week.

Table	1
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Information Criteria of the Longitudinal Latent Class Models

	Full noninvariance	Full invariance
Two-class solution		
BIC	2662.111	2587.704
AIC	2538.684	2540.232
aBIC	2538.610	2540.203
Three-class solution		
BIC	2726.454	2591.834
AIC	2511.249	2490.561
aBIC	2511.120	2490.500
Four-class solution		
BIC	2843.562	2654.462
AIC	2517.589	2480.399
aBIC	2517.393	2480.294
Five-class solution		
BIC	3015.593	2772.273
AIC	2559.864	2506.431
aBIC	2559.590	2506.271

Note. BIC = Bayesian information criterion; AIC = Akaike information criterion; aBIC = adjusted Bayesian information criterion.

two-class solution. In addition to two of the three information criteria favoring the four-class solution, the four-class solution provided more readily interpretable classes than the two-class solution at very closely matched classification entropy (.845 for the two-class solution and .812 for the four-class solution).

On the basis of this information, the model with four classes and full measurement invariance was chosen. These four timeinvariant latent classes reflected theoretically meaningful groupings of neighboring LoDs. A theoretical hierarchy was imposed on the basis of the extent to which classes were characterized by relative predominance of LoD1 or LoD4. Henceforth, classes are presented in this meaningful order instead of the arbitrary order of their extraction. As depicted in Table 2 participants in Class A almost exclusively endorsed LoD1, making this class interpretable as "focus on self-reliance." Participants allocated to Class B had high probabilities of endorsing all LoDs except LoD4, making this response pattern interpretable as "using aids and help and considering self-reliance." Members of Class C were very likely to endorse LoD2 and also showed a lower but non-negligible probability of endorsing LoD3. Therefore, we termed this class "focus on technical aids." Participants in Class D were highly likely to endorse both LoDs 2 and 3, but also endorsed the final LoD4 albeit at a much lower probability. This class was interpreted as "using aids and help and considering disengagement."

Transitions Between Classes Over Time (H1)

Figure 1 depicts the latent class probabilities at each occasion as

Table 2					
Item Phrasing	and	Class-Specific	Endorsement	Probabilities	of the LoDs

	During the past week,	Class A	Class B	Class C	Class D
LoD1	it was my goal to independently accomplish activities of daily life (e.g., work, household, shopping, social activities, hobbies) without using pads or other technical aids.	.792	.704	.124	.108
LoD2	it was my goal to independently accomplish activities of daily life by using pads or other technical aids.	.114	.822	.839	.984
LoD3	it was my goal to accomplish activities of daily life by using pads or other technical aids and support by others (e.g., my partner, close others).	.000	.913	.302	.999
LoD4	it was my goal to also refrain from pursuing pleasurable activities rather than worry about unpleasant consequences of incontinence all the time.	.000	.000	.115	.319

Note. N = 175. LoD = line of defense; Class A = "focus on self-reliance"; Class B = "using aids and help and considering self-reliance"; Class C = "focus on technical aids"; Class D = "using aids and help and considering disengagement."

class was often the most probable transition. This resulted in the probabilities of Class A membership growing over time while Class D membership became less likely. In line with the theoretical hierarchy, direct transitioning from the "lowest" Class D to the "highest" Class A was very improbable with probabilities less than .10. Instead, detours via Classes C or B were necessary. Interestingly, but not in line with the imposed hierarchy, there was hardly any upward or downward direct exchange between the two intermediate Classes C "focus on technical aids" and B "using aids and help, and considering self-reliance." Only between T3 and T4 a small probability (.15) to transition from Class C to Class B emerged. The few downward transitions among classes featured low probabilities: Transition probabilities of .13 (T1 to T2) and .12 (T3 and T4) indicated that some persons gave up the sole "focus on technical aids" (Class C) and began to set goals to "use aids, help, and consider disengagement" (Class D).

Incontinence as a Correlate of Class Membership (H2)

As depicted in Figure 2, persons with the lowest incontinence (0) had substantially higher odds to be members of Class A "focus

on self-reliance" than of Class D "use aids, help, and consider disengagement" for all but the first measurement occasions. Moreover, odds of being a member of Class A and not of Class D decreased significantly with increases in incontinence at all four measurement occasions ($b_{T1} = -0.517$, 95% confidence interval [CI] [-3.737, -0.375], odds ratio $[OR]_{T1} = 0.596$, $b_{T2} = -1.163$, 95% CI [-174.342, -0.817], $OR_{T2} = 0.313$, $b_{T3} = -1.007$, 95% CI [-39.313, -0.437], $OR_{T3} = 0.365$, $b_{T4} = -0.565$, 95% CI [-21.726, -0.296], $OR_{T4} = 0.568$). Panels of Figure 2 also reveal that lines representing predicted membership in the highest Class A and in the lowest Class D intersected at higher levels of incontinence at later points in time. This indicates that at later occasions the degree of incontinence which was acceptable for Class A "focus on self-reliance" membership (with Class D being the reference) was noticeably higher than at T1.

Except for T1, findings also supported an intermediate position of Class B "using aids and help, but considering self-reliance" on the incontinence spectrum (see Figure 2), with odds of Class B membership decreasing at higher levels of incontinence ($b_{T1} = -0.219$, 95% CI [-2.097, 0.042], $OR_{T1} = 0.803$;

	Class Probabilities	es Transition Probabilities				Class Probabilities Transition Probabilities					Class Probabilities Transition Probabilities				ies	Class Probabilities
	Τ1		Class	at T2		To		Class	at T3		TTO		Class	at T4		TT 4
		Cl. A	Cl. B	Cl. C	Cl. D	T2	Cl. A	Cl. B	Cl. C	Cl. D	T3	Cl. A	Cl. B	Cl. C	Cl. D	T4
Class A	0.12	0.95	0.00	0.00	0,05	0.29	0.96	0.03	0.02	0.00	0.39	0.91	0.09	0.00	0.00	0.50
Class B	6.1)	0.65	0.35	0.00	0.00	0.14	0.22	0.78	0.00	0.00	6.1)	0.40	0.60	0.00	0.00	0.15
Class C	0.32	0.35	0.00	0.52	0.13	0.23	0.28	0.00	0.72	0.00	0.21	0.37	0.15	0.36	0.12	0.12
				-												

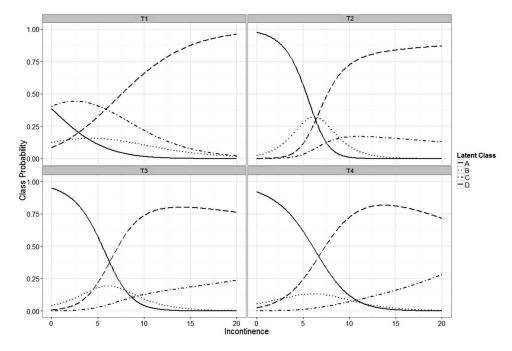


Figure 2. Relationships between class membership and incontinence. Class A: "focus on self-reliance." Class B: "using aids and help and considering self-reliance." Class C: "focus on technical aids." Class D: "using aids and help and considering disengagement." T1: 1 month following the onset of incontinence, T2: 3 months, T3: 5 months, T4: 7 months following the onset of incontinence.

 $b_{T2} = -0.548$, 95% CI [-170.158, -0.266], $OR_{T2} = 0.578$; $b_{T3} = -0.475$, 95% CI [-38.206, -0.221], $OR_{T3} = 0.622$; $b_{T4} = -0.260$, 95% CI [-21.105, -0.095], $OR_{T4} = 0.771$). Class C membership peaked at zero incontinence at T1, but its relations with incontinence could not be reliably differentiated from membership in Class D at the remaining occasions.

Discussion

This study investigated a direct operationalization of the LoDs model (Heckhausen, 2005; Heckhausen et al., 2013) within the context of rehabilitation from postsurgery urinary incontinence following RP. A theory-based hierarchy of four LoD-classes that resembled the proposed sequence of engagement with LoDs was successfully modeled to the data. Consistent with H1, more upward than downward transitions occurred over time within the proposed hierarchy of classes. Moreover, probabilities of downward transitions were consistently low. Although evidence of a hierarchical sequence of intermediate Classes B and C was mixed, this overall pattern of findings nevertheless supported the theoret-

in patients early on. Commencing at T2, probabilities of membership in Class A mostly peaked at lowest levels of incontinence, Class B peaked at an intermediate level, and Class D at the highest. That Class C membership failed to show significant differentiation from Class D when it came to its associations with incontinence, may lend indirect support for Class C's position in the proposed hierarchy of classes.

Additionally, findings indicated a growing "tolerance" of incontinence in Class A. Part of this effect may have been driven by premature upward movements to Class A that were followed by corrective downward movements again. More likely, however, this dissociation reflected some patients' growing desire to return to presurgery routines and in this process to tolerate some incontinence while managing it with minimized dependence on technical aids and others' help (Resendes & McCorkle, 2006). The latter explanation implies an asymmetry of upward and downward movement among LoDs in the sense that persons may be more inclined to move upward the LoD hierarchy upon even small improvements in functional health, but resist downward movement as long as possible.

This study had several limitations. As this was the first attempt at

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in future studies, for example in a context where close family members are not available for daily assistance. Also, the one-item per LoD assessment may pose problems for reliable measurement. Potentially limiting generalizability, this study only included patients who were living in a relationship with a heterosexual partner. Conclusions are further limited by a selection bias toward patients who experienced fewer difficulties in managing daily activities and patients with partners who had additional vocational training.

As the LoD-framework was originally developed for the context of progressing disease and because findings imply a potential asymmetry between upward and downward movements among LoDs, the model should also be investigated with populations facing diseases that are characterized by a high variability in speed of progression and/or recovery. Moreover, the LoDs model proposes that goal engagement and disengagement take place in discrete shifts rather than gradual processes (Heckhausen et al., 2013). However, except for persons belonging to Class A (dominated by LoD1), goal choice in all other classes involved two or three neighboring LoDs at a time. Possibly, this more dynamic and flexible pattern of goal choice reflects the unique short-term characteristics of postsurgical rehabilitation. Future work should thus address the proposition of distinct shifts between goal engagement and disengagement within the LoD-framework and take into account temporal issues, including length of follow-up and interassessment interval.

In sum, this study was the first to directly investigate the LoDs model (Heckhausen, 2005; Heckhausen et al., 2013). In line with the model's predictions, ordered upward adjustments of functional goals or LoDs were shown in a context of recovery from incontinence following RP. Overall, patients matched their LoDs to the concurrent level of incontinence, thereby promptly claiming enhanced and independent functioning with physical improvements.

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