

User manual
for the
TNM Classification System for
Prosthetic Joint Infections

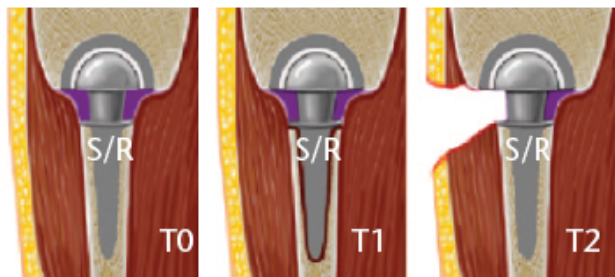
In the following, the TNM classification system for prosthetic joint infections (PJI) is introduced step by step and explained in further detail using the example provided below.

This should serve as a guideline for the classification of the PJIs of 20 randomly selected patients in the attached case presentation.

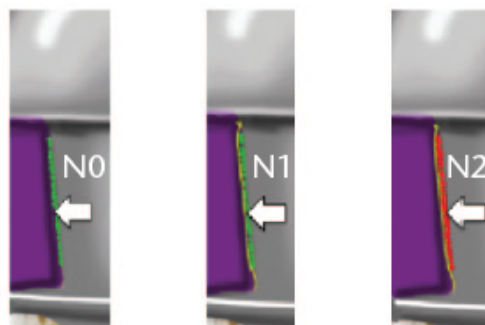
Example:

“Chronic knee PJI, one year after implantation and loosened standard implant without severe soft tissue defect with a ciprofloxacin-resistant *Pseudomonas aeruginosa*, mildly compromised host (relevant pre-existing conditions: heart failure).”

TNM Classification System for Prosthetic Joint Infections



Tissue and implant conditions			
T	T0	a	Stable standard implant without important soft tissue defect
		b	Stable revision implant without important soft tissue defect
	T1	a	Loosened standard implant without important soft tissue defect
		b	Loosened revision implant without important soft tissue defect
	T2	a	Severe soft tissue defect with standard implant
		b	Severe soft tissue defect with revision implant



Non-human cells (bacteria and fungi)			
N	N0	a	No mature biofilm formation (<i>former: acute</i>), directly postoperatively
		b	No mature biofilm formation (<i>former: acute</i>), late haematogenous
	N1	a	Mature biofilm formation (<i>former: chronic</i>) without "difficult to treat bacteria"
		b	Mature biofilm formation (<i>former: chronic</i>) with culture negative infection
	N2	a	Mature biofilm formation (<i>former: chronic</i>) with "difficult to treat bacteria"
		b	Mature biofilm formation (<i>former: chronic</i>) with polymicrobial infection
		c	Mature biofilm formation (<i>former: chronic</i>) with fungi



Morbidity of the patient			
M	M0	Not or only mildly compromised (Charlson Comorbidity Index: 0-1)	
	M1	Moderately compromised patient (Charlson Comorbidity Index: 2-3)	
	M2	Severely compromised patient (Charlson Comorbidity Index 4-5)	
	M3	a	Patient refuses surgical treatment
		b	Patient does not benefit from surgical treatment
		c	Patient does not survive surgical treatment

r reinfection

If the infection involves a previously infected implant, the situation is considered as "reinfection" and an "r" is put in front of the classification, e.g. rT1aN1aM2

The name of the **affected joint** is put in front of the TNM letters in order to clearly state the affected body region, such as hip, knee, or shoulder

Based on the example:
“Chronic knee PJI [...]”

➔ **Knee-PJI-TxNxMx**

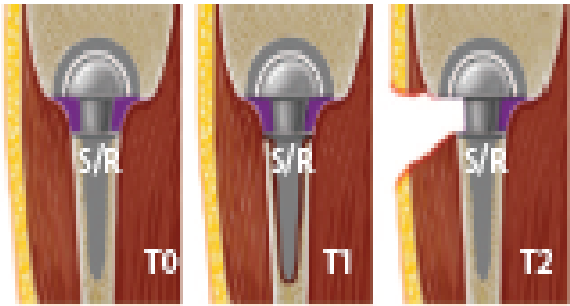
r

reinfection

If the infection involves a previously infected implant, the situation is considered as “reinfection” and an “r” is put in front of the classification, e.g. rT1aN1aM2

If it is a recurrence of infection, the letter ‘r’ is put additionally in front of the affected joint in order to emphasize reinfection.

T			Tissue and implant conditions
T0	a		Stable standard implant without important soft tissue defect
	b		Stable revision implant without important soft tissue defect
T1	a	→	Loosened standard implant without important soft tissue defect
	b		Loosened revision implant without important soft tissue defect
T2	a		Severe soft tissue defect with standard implant
	b		Severe soft tissue defect with revision implant



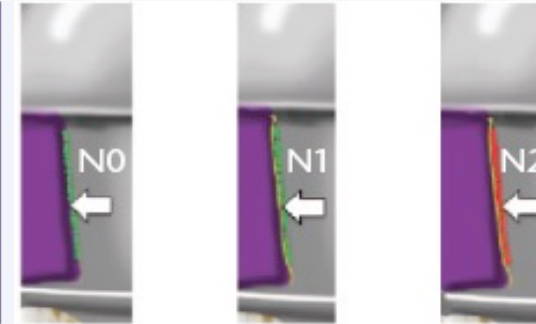
→ „T“ represents the local situation of the tissue and the indwelling implant

Based on the example:

“ [...] loosened standard implant without severe soft tissue defect [...]”

→ Knee-PJI-T1a

Non-human cells (bacteria and fungi)			
N	N0	a	No mature biofilm formation (<i>former: acute</i>), directly postoperatively
		b	No mature biofilm formation (<i>former: acute</i>), late hematogenous
	N1	a	Mature biofilm formation (<i>former: chronic</i>) without "difficult to treat bacteria"
		b	Mature biofilm formation (<i>former: chronic</i>) with culture negative infection
	N2	a	→ Mature biofilm formation (<i>former: chronic</i>) with "difficult to treat bacteria"
		b	Mature biofilm formation (<i>former: chronic</i>) with polymicrobial infection
c		Mature biofilm formation (<i>former: chronic</i>) with fungi	



→ „N“ represents the microbiological conditions and findings

Based on the example:

“Chronic’ knee PJI [...] with a ciprofloxacin-resistant *Pseudomonas aeruginosa* [...]”

→ Knee-PJI-T1a**N2a**

Morbidity of the patient

M

M0		Not or only mildly compromised (Charlson Comorbidity Index: 0-1)
M1		Moderately compromised patient (Charlson Comorbidity Index: 2-3)
M2		Severely compromised patient (Charlson Comorbidity Index 4-5)
M3	a	Patient refuses surgical treatment
	b	Patient does not benefit from surgical treatment
	c	Patient does not survive surgical treatment



M0 **M1** **M2** **M3**

→ „M“ addresses the general health status of the patient using the Charlson Comorbidity Index

Condition	Score
Myocardial infarction ¹	1
Heart failure ²	1
Peripheral arterial disease ³	1
Cerebrovascular disease ⁴	1
Dementia ⁵	1
Chronic pulmonary disease ⁶	1
Connective tissue disease ⁷	1
Peptic ulcer disease ⁸	1
Mild liver disease ⁹	1
Diabetes without end-organ damage ¹⁰	1
Hemiplegia	2
Moderate-to-severe kidney disease ¹¹	2
Diabetes with end-organ damage ¹²	2
Tumor disease ¹³	2
Leukemia ¹⁴	2
Lymphoma ¹⁵	2
Moderate-to-severe liver disease ¹⁶	3
Metastatic solid tumor	6
AIDS (not only HIV-positive)	6

- 1 Patients with status post myocardial infarction
- 2 Patients with strain-induced dyspnoea, nocturnal dyspnoea, angina pectoris, or coronary bypass
- 3 Patients with intermittent claudicatio, after peripheral bypass, with acute arterial occlusion or gangrene and untreated abdominal or thoracic aortic aneurysm greater than 6 cm
- 4 Patients with TIA or stroke with no or only minor residuals
- 5 Patients with chronic cognitive deficiency
- 6 Patients with pulmonary dyspnoea under mild or moderately severe physical stress without therapy or patients with attacks of dyspnoea (asthma)
- 7 Polymyalgia rheumatica, lupus erythematosus, severe rheumatoid arthritis, polymyositis
- 8 Patients who have previously been treated for ulcers
- 9 Cirrhosis of the liver without portal hypertension
- 10 Patients with diabetes mellitus and drug therapy
- 11 Requirement for dialysis or creatinine >3mg/dl
- 12 Retinopathy, neuropathy or nephropathy
- 13 Any solid tumors without metastases within the last five years
- 14 Acute and chronic leukemia
- 15 Hodgkin's and non-Hodgkin lymphomas, multiple myeloma
- 16 Cirrhosis of the liver with portal hypertension without bleeding and patients with varicose vein bleeding

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M

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M2		Severely compromised patient (Charlson Comorbidity Index 4-5)
M3		
	a	Patient refuses surgical treatment
	b	Patient does not benefit from surgical treatment
	c	Patient does not survive surgical treatment

Based on the example:

“mildly compromised host suffering from heart failure as the only relevant pre-existing condition”

Knee-PJI-T1aN2a**M0**

Condition	Score
Myocardial infarction ¹	1
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Cerebrovascular disease ⁴	1
Dementia ⁵	1
Chronic pulmonary disease ⁶	1
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AIDS (not only HIV-positive)	6

Resources and further literature:

Alt V, Rupp M, Langer M, Baumann F, Trampuz A. Can the oncology classification system be used for prosthetic joint infection?: The PJI-TNM system. *Bone & Joint Research*. 2020;9(2):79-81.

Alt V, Rupp M, Langer M, Baumann F, Trampuz A. Infographic: Can the oncology classification system be used for prosthetic joint infection?: The PJI-TNM system. *Bone & Joint Research*. 2020;9(2):77-78.

Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383.