Procalcitonin (PCT)

Effective management of surgical site infections

B·R·A·H·M·S PCT: Superior to CRP in identifying infections

thermo scientific

Surgical site infection (SSI)

The global burden of post-operative infections

SSIs are among the most common healthcare-associated infections (HAI). They are connected with[1]

- longer post-operative hospital stays
- additional surgical procedures
- treatment in intensive care units
- higher mortality

Up to 10%
of surgical patients in the EU are likely to develop SSIs, depending on the type of surgical procedure[1]

500,000
people per year are affected by SSI in Europe[2]

~1/10
people who have surgery in Low and Middle Income Countries acquire a SSI[2]

2–5%
of patients undergoing inpatient surgery develop a SSI in the US[3]

~7–10
additional postoperative hospital days in the US[3]

2–11
times higher risk of death compared with operated patients without a SSI in the US[3]

up to 20%
of caesarean section procedures in Africa lead to a wound infection[2]

$ 11,000–35,000
estimated cost per SSI in the US[4]

Identify SSIs early

PCT supports detection of infectious complications after surgery

PCT (procalcitonin) is a biomarker that provides insights into the risk of a patient having a bacterial infection, as well as the severity of that infection. The laboratory test **Thermo Scientific™ B·R·A·H·M·S PCT™** supports earlier and better diagnosis, clinical decision making for systemic bacterial infections and therapy control due to its following main characteristics:[5,6,7]

- **High sensitivity and specificity for bacterial infection**
- **Fast increase after bacterial infection** within 3–6 hours (faster than CRP)
- **Assessment of disease severity, prognosis and antibiotic stewardship**

Independent of an infectious process, the PCT level can be slightly elevated shortly after multiple trauma or major surgery. It peaks on the first or second day after surgery and returns to baseline. In case, if there is a higher increase in PCT level or if there is a second peak, this could be a likely indication of an infectious complication.[8]

An early increase of PCT after surgery allows detection of SSI before clinical signs become evident.

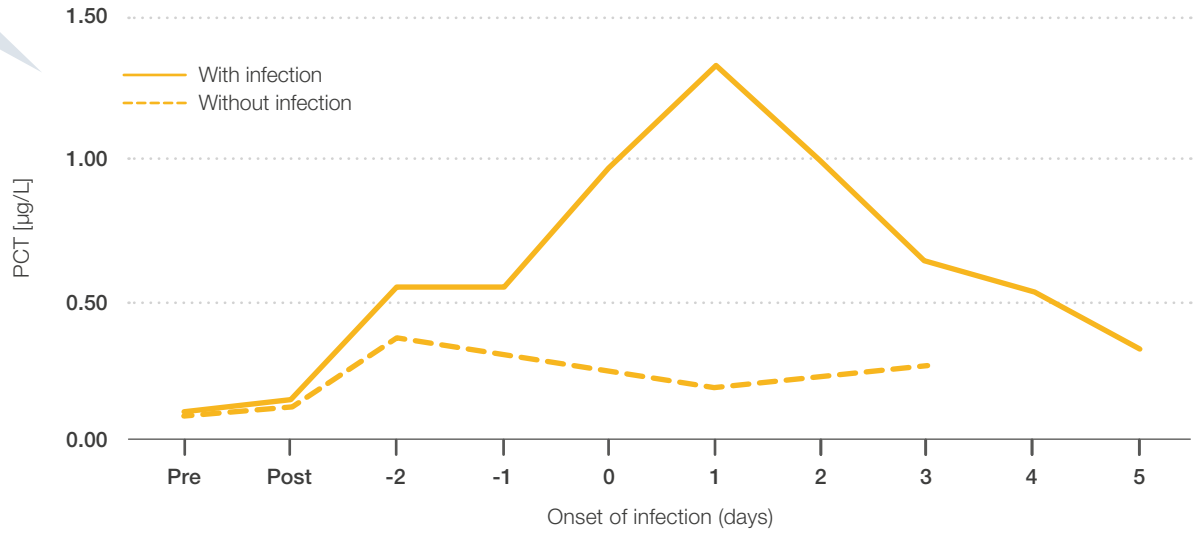


Figure 1. PCT in patients after major aortic surgery with infection (n=67) and without infection (n=209) over the days before and after surgery[9]

Serial PCT measurements can help to differentiate postoperative infectious complications from a transient unspecific PCT rise due to surgical trauma.[8]

PCT is superior to CRP

Identifying infections with high accuracy

Bacterial infection

Unspecific induction due to surgery or trauma is lower and shorter for PCT compared to CRP due to higher specificity to bacterial infection and faster kinetics.[6]

PCT levels increase significantly higher in patients with sepsis, or septic shock and also in non-survivors than in survivors in contrast to CRP.[10]

Compared with CRP the rise of PCT levels has a higher specificity for bacterial infection and is less impacted by non-infectious surgery- or trauma-associated inflammation.[11]

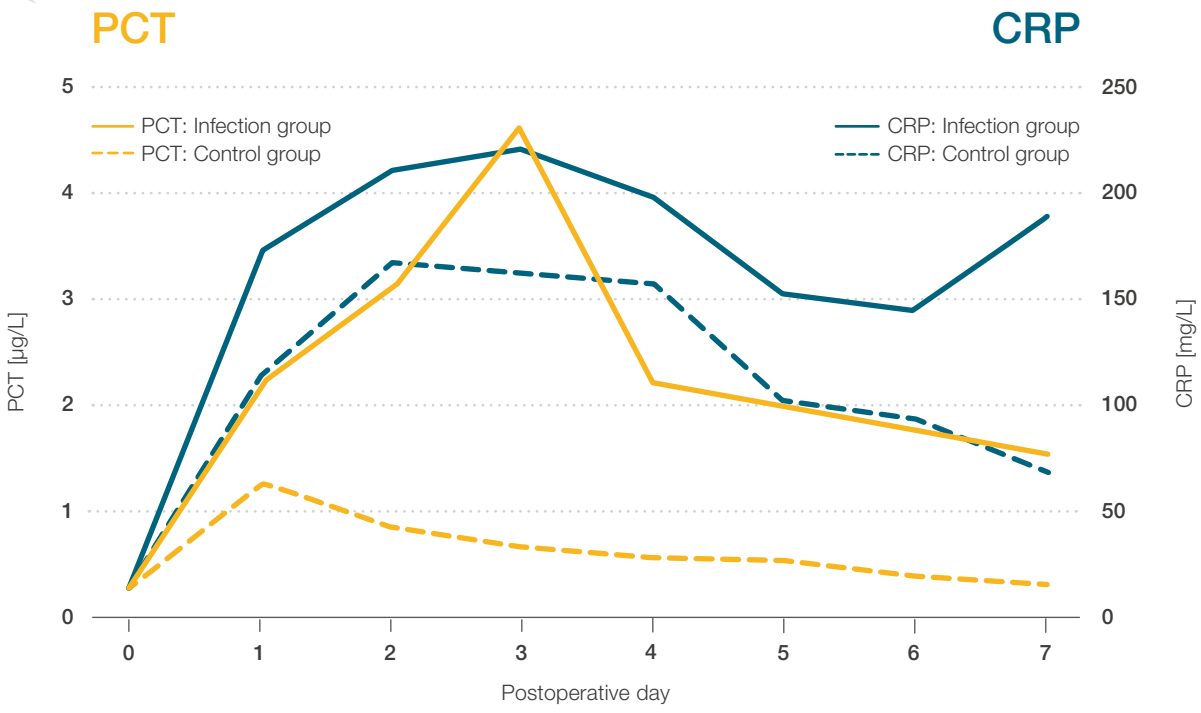
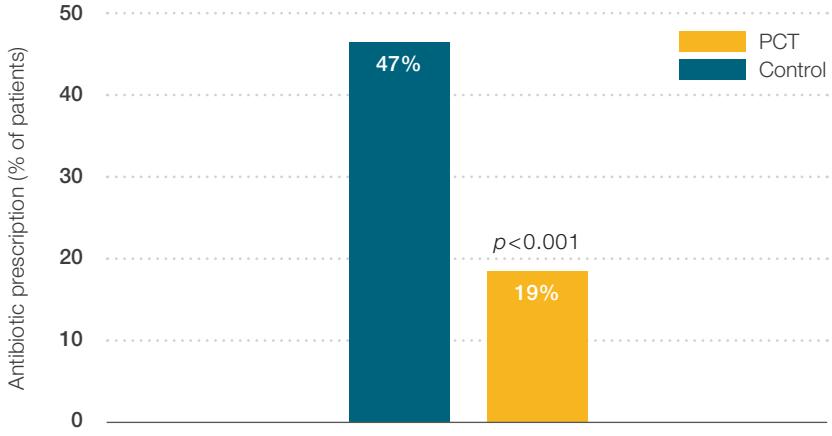


Figure 2. Comparison of PCT and CRP in the control (n=84) and infection groups (n=16) after cardio-pulmonary bypass[10]

PCT-aided antibiotic therapy

Reducing antibiotic exposure, ICU days, and costs

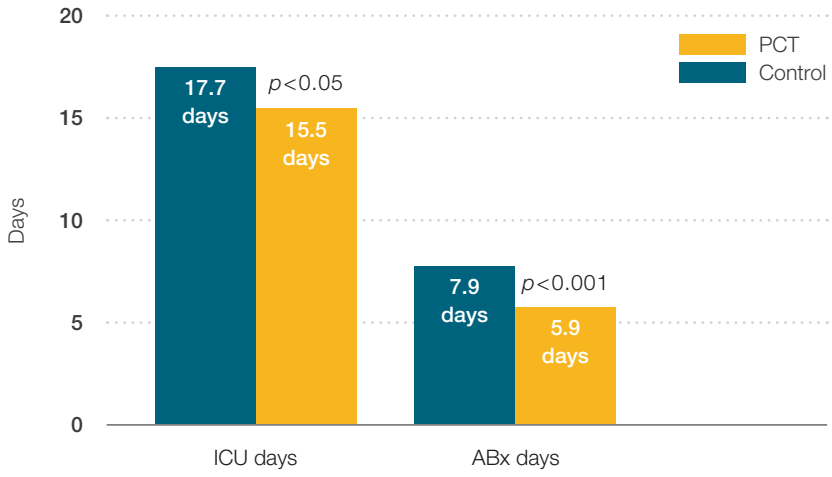


-60%

prescribed antibiotics in patients after **open heart surgery**[12]

Without negative impact on clinical outcome (morbidity or mortality)[12]

Figure 3. Antibiotic prescription (% of patients) after open heart surgery in control group vs. PCT group (discouraging antibiotic use in patients with PCT <0.5 µg/L) in addition to clinical symptoms (n=205)[12]



-12%

ICU days[13]

-25%

ABx days in surgical ICU patients[13]

Without negative impact on clinical outcome[13]

Figure 4. Duration of ICU stay and of antibiotic therapy in surgical intensive care patients receiving antibiotic therapy aided by PCT algorithm after confirmed or high-grade suspected infections (n=110) (ABx days = days of antibiotic therapy)[13]

PCT-aided antibiotic stewardship algorithm can help reduce the antibiotic exposure in surgical patients.

Intra-abdominal infectious complications

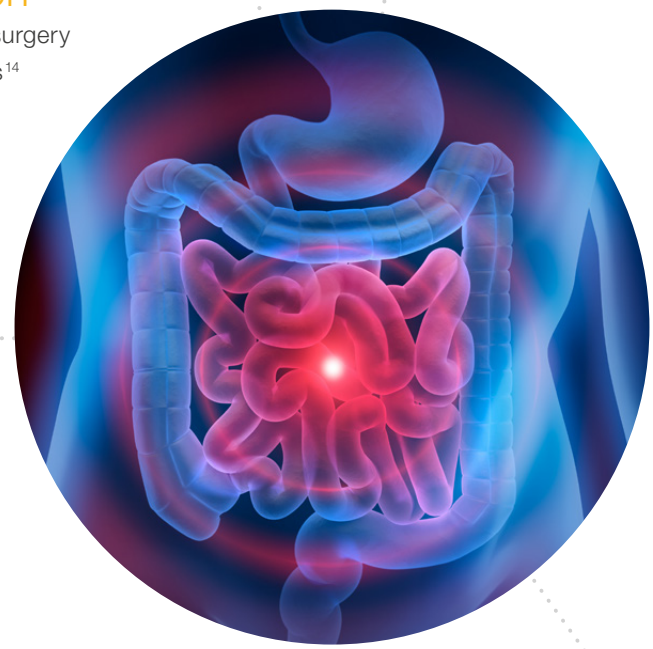
Utility of PCT for antibiotic (ABx) and surgical decisions

Acute pancreatitis

-17% ABx initiation[15]
-32% ABx treatment[16]
-25% ICU days[16]
-12% hospitalization costs[16]
in patients with severe acute pancreatitis

Secondary peritonitis

50% relative reduction in ABx duration
in patients undergoing surgery for secondary peritonitis[14]



Appendicitis

89% sensitivity
90% specificity
for diagnosis of complicated appendicitis in children[18]

Diverticulitis

PCT **>0.1 µg/L**
indicates complicated diverticulitis which needs ABx therapy[17]

Anastomotic leakage

NPV **≥99%**
in excluding anastomotic leaks (AL) after a colorectal resection: combination of PCT, CRP and Dutch Leakage Score (DLS) allows the exclusion of AL in the early postoperative period[19]

NPV Negative predictive value. **POD** Postoperative day.

Cardiac surgery

PCT predicts infection with good sensitivity and specificity

81% sensitivity
82% specificity
to identify postoperative infections
in cardiac surgery patients → helps avoid unnecessary ABx in non-infected patients[20]

Better precision
than CRP and IL-6
Postoperative increased serum PCT levels predict infection more precisely than CRP[21] and IL-6[22]

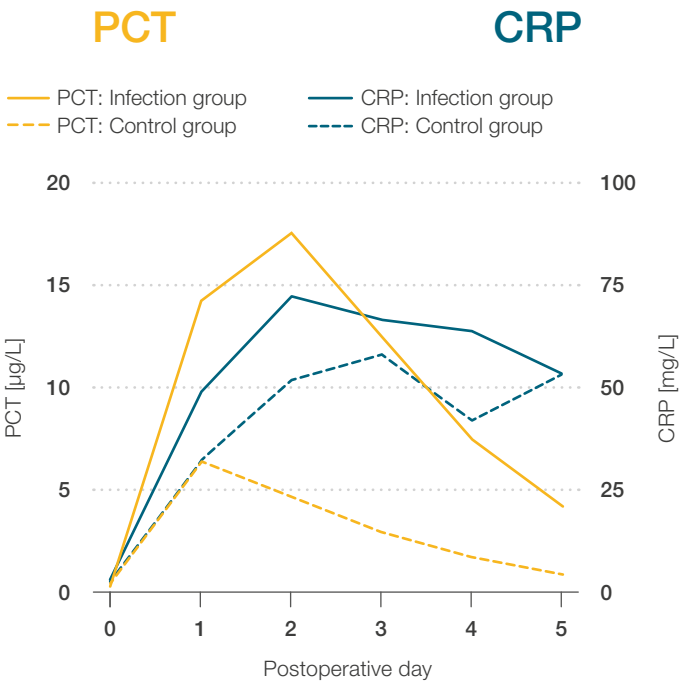


Figure 5. Trends in PCT and CRP levels in infected vs. non-infected patients with Delayed Sternal Closure (n=27).[21] The difference in PCT levels was significant between the infected vs. non-infected patients from POD2 onwards ($p<0.05$).

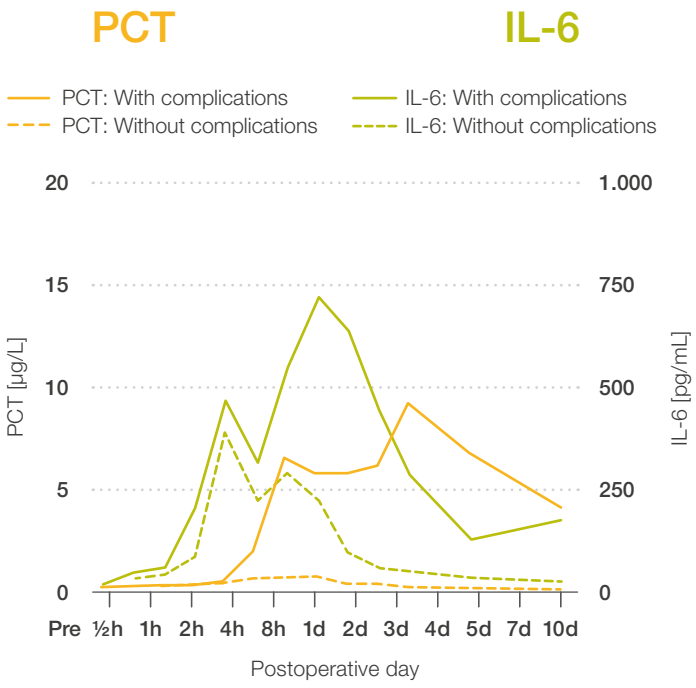


Figure 6. Comparison of PCT and IL-6 in patients undergoing aortal surgery (n=35)[22]

After cardiac surgery, the transient rise of PCT without infectious complications usually happens within 24 hours. (Figures 5 and 6).[21,22]

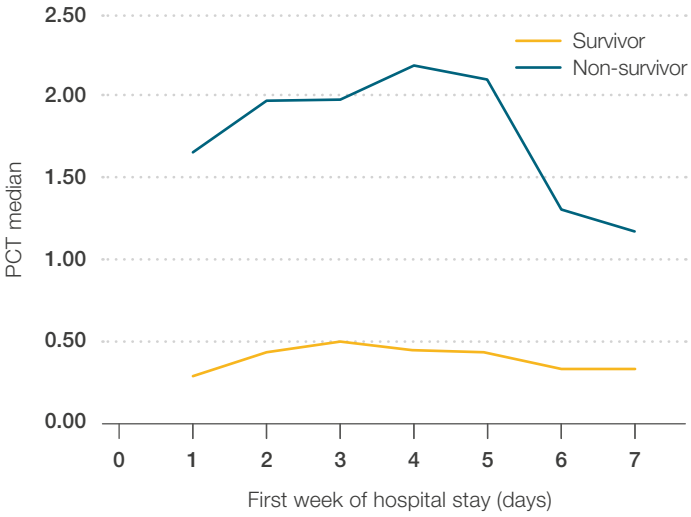
Meta-analysis of 34 studies of PCT after cardiac surgery revealed that cut-off points for discriminating infection depend on the surgical procedures and on intra-operative events.[23]

Thus, the dynamics of PCT levels over time may be more important than absolute values.

Severe burns

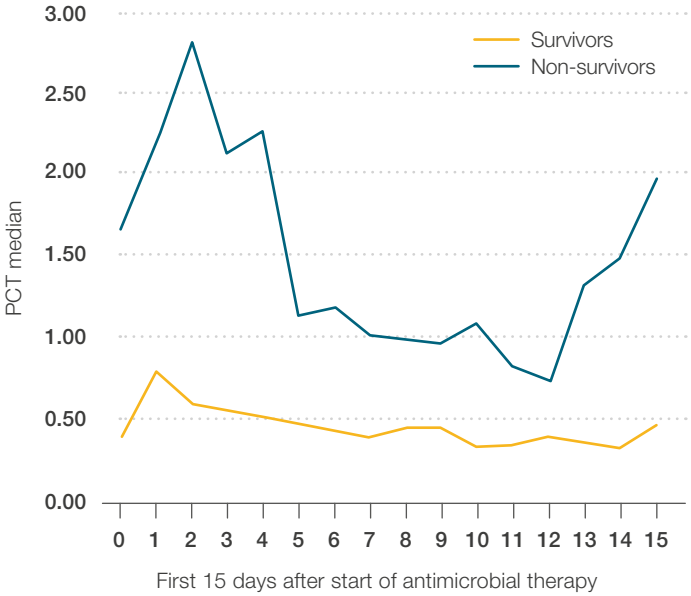
Prognostic power in high inflammatory state

Due to greater infection susceptibility, sepsis is the main cause of death in burn patients. Quick diagnosis and patient stratification, early and appropriate antimicrobial therapy, and focus control are crucial for patients' survival.



PCT parallels the **evolution of the infectious process**[24]

Figure 7. Line plots of PCT levels evolution along the first week of hospitalization in 101 patients. Differences between PCT levels of patients from the survivor and non-survivor groups are statistically significant ($p<0.001$).[24]



PCT reflects the **efficacy of antimicrobial therapy**[24]

Figure 8. Line plots of PCT levels evolution in the first 15 days of antimicrobial therapy in 101 patients. In non-survivors the PCT levels were significantly elevated from the beginning, with further increase during the last days of life. In the survivor group, PCT levels declined rapidly and remained low.[24]

Serial PCT measurements can help to

- **monitor the efficacy of antimicrobial therapy, allowing faster de-escalation or stop without increasing mortality**
- **stratify patients who need more intensive care**
- **predict outcomes**

Post-transplantation

Rejection or infection?

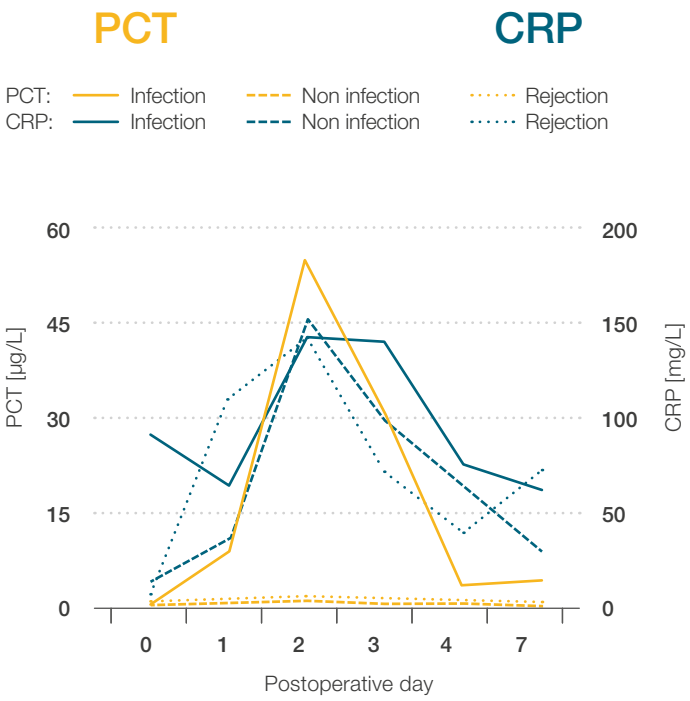


Figure 9. Mean serum values of PCT and CRP in 25 lung transplantation patients with or without infection or with rejection over time[25]

Lung transplant

High specificity

in detecting infectious complications in patients after lung transplantation[25]

In cases of rejection or primary graft dysfunction (PGD) grade 1 & 2, PCT remains low, thus allowing for differentiation from infection[25]

Liver transplant

Pre-transplant serum PCT >0.5 µg/L indicates the likelihood of infection

in patients undergoing living donor liver transplantation (LDLT)[26]

→ **Patient should be re-evaluated regardless of systemic symptoms**

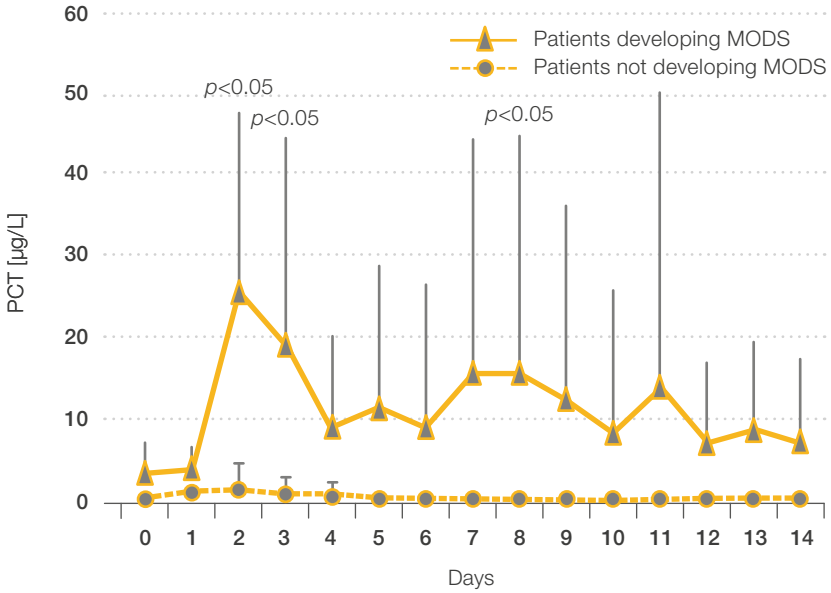
→ **Rescheduling of liver transplant should be considered**

An infection, but not rejection, causes an early and dramatic increase in PCT and allows the identification of infectious complications in contrast to CRP.[25,27]

Multiple trauma

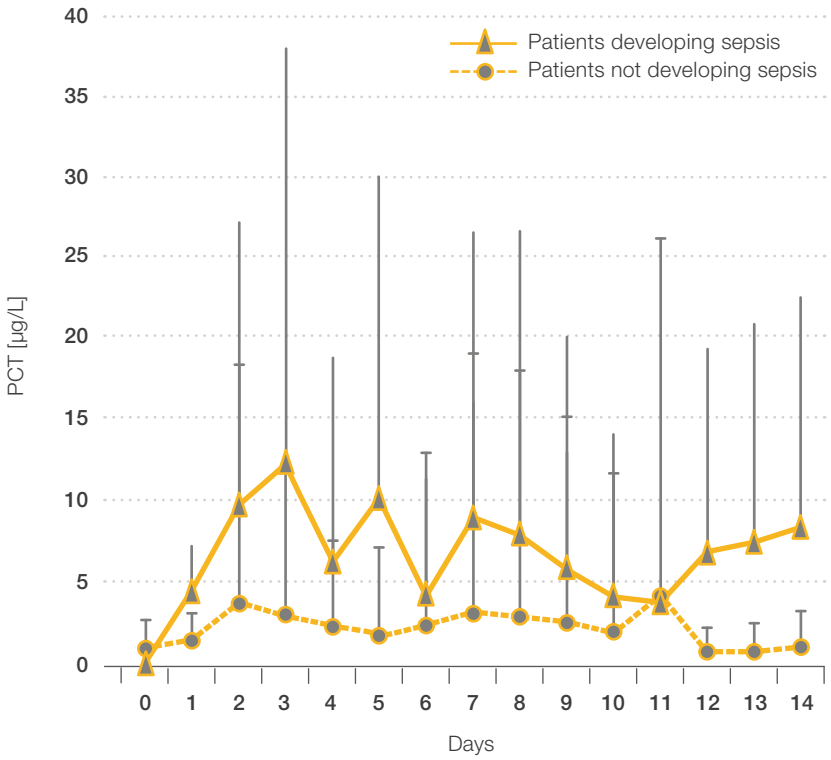
Prediction of post-traumatic MODS

Multiple organ failure is a major cause of morbidity in blunt multiple traums patients. The evaluation of clinical condition and the identification of patients at risk after multiple trauma is one of the biggest problems in multiple trauma therapy.



PCT is useful in
early identification of high risk patients
who could develop post-traumatic Multi Organ Dysfunction Syndrome (MODS)[28]

Figure 10. PCT showed significantly higher levels in patients developing MODS (n=21) compared with patients not developing MODS (n=73)[28]



The increase of PCT plasma levels precedes the clinical diagnosis of sepsis and MODS
up to 3 days[28]

Figure 11. PCT showed higher levels in patients developing sepsis (n=15) compared with patients not developing sepsis (n=79)[28]

In trauma patients, initial peak PCT levels may be used as an early predictor of severity of injury, development of sepsis and Multi Organ Dysfunction, and mortality. Serum PCT levels may contribute to the identification of patients who may benefit most from more aggressive management.[29]

B·R·A·H·M·S

PCT

The power of PCT allows to

Early identify surgical site infections

Safely reduce antibiotic exposure

Confidently secure treatment decisions

Fewer systemic complications from infection

Lower incidence of sepsis

Shorter duration of antibiotic treatment

Shorter length of hospital stay

ThermoFisher SCIENTIFIC

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Secured clinical decision making independent of platform

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LSI Medience	PATHFAST™ B·R·A·H·M·S PCT
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Clinical Diagnostics

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