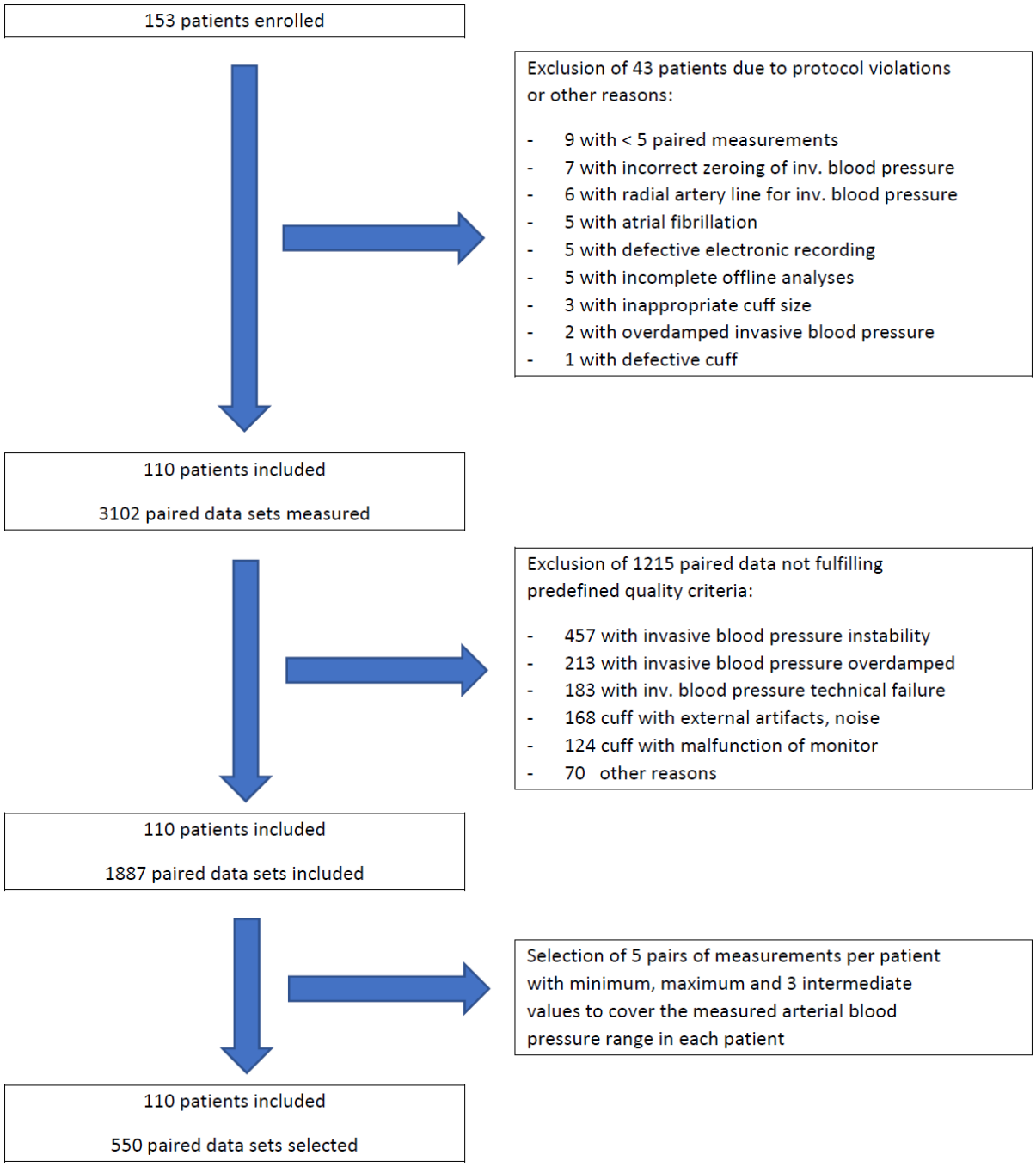
Supplemental Digital Content 1:
Details on patient inclusion and selection of paired measurements

Figure S1:
Flow chart of patient inclusion and selection of paired measurements:



1. Procedure of measurements and data transmission:

Between November 13, 2013 and April 5, 2018, we enrolled and analyzed 153 patients undergoing elective major abdominal surgery or neurosurgery at the three study sites. According to the study protocol (incorporated in the data management software, UP-Med GmbH, Munich, Germany), the clinical investigator had to confirm that the following issues were checked and documented before each measurement:

1.1. Controlled mechanical ventilation with Vt ≥ 8ml/kg predicted body weight
1.2. Supine position, arm-to-body angle ≥ 30°
1.3. Patient's upper arm must fit one of the provided cuff sizes
1.4. Recording monitor: The calibration of both, the invasive and the noninvasive blood pressure channel, was checked at 100 mmHg with separate test pressure transducers and compared to a filled water hose with 136 cm water column. Deviation had to be <± 3 mmHg
1.6. Correct zeroing of invasive and noninvasive blood pressure at heart level
1.7. No offset on either pressure signal channel

During the measurements in the operating room, the investigator had no information about the measurement results of the high-fidelity cuff. The recorded data had been anonymized, electronically encrypted end-to-end and transmitted via cloud to UP-MED GmbH, Munich, Germany.

2. Offline data classification and evaluation:

In a next step, two experts independently analyzed the data using the recording diagrams of each paired measurement. In case of different ratings both experts tried to find a joint classification, if no agreement could be achieved, the measurement was excluded. According to the study protocol, the data had to fulfill the following predefined quality criteria:

2.1 Mechanical ventilation:
- 2.1.1 Controlled mechanical ventilation with Vt ≥ 8ml/kg predicted body weight
- 2.1.2 > 3 in invasive blood pressure recordings visible ventilation cycles in between DBP and SBP, i.e. in the pulse pressure range

2.2 Classification of heart rhythm: sinus rhythm or intermittent arrhythmia or atrial fibrillation
2.3 Invasive arterial pressure waveforms:
- 2.3.1 No dampening of arterial blood pressure waveform
- 2.3.2 No invasive arterial blood pressure changes during measurement, i.e. no slow drifts of MAP ≥ 10 mmHg or no transient bumps, decrease, or increase in MAP ≥ 10 mmHg within 60s of measurement window
- 2.3.3 No relevant artifacts

2.4 Tissue pressure signals of high-fidelity cuff:
- 2.4.1 Slow inflation starts at sensor pad pressure (Pcl) < DBP -10 mmHg
- 2.4.2 Maximum inflation pressure of Pcl > SBP + 10 mmHg
- 2.4.3 After deflation Pcl drops below 15 mmHg

3. Exclusion of patients

Data from 43 patients were excluded a priori as a whole due to serious protocol violations for technical or patient-related reasons. Typical reasons for protocol violation were:

3.1. Less than 5 paired measurements (9 patients)
3.2. Incorrect zeroing of invasive arterial blood pressure (7 patients), Fig. S2
3.3. Use of radial artery line for blood pressure measurements (6 patients)
3.4. Varying invasive arterial blood pressure waveforms due to atrial fibrillation (5 patients), Fig. S3
3.5. Defective electronic recording (5 patients), Fig. S4
3.4. Incomplete offline analyses (5 patients)
3.7. Inappropriate size of the high-fidelity cuff (3 patients)
3.8. Overdamped invasive blood pressure curves in all paired measurements (2 patients)
3.9. Defective high-fidelity cuff (1 patient)

Common reasons for exclusion were < 5 paired measurements, incorrect zeroing (Fig. S2) or defective electronic recording (Fig. S4) of invasive arterial blood pressure measurements, whereas varying arterial blood pressure waveforms due to atrial fibrillation was a patient-related reason for exclusion (Fig. S3).

Figure S2.
Exclusion of 70-year-old female patient due to incorrect zeroing of invasive arterial blood pressure

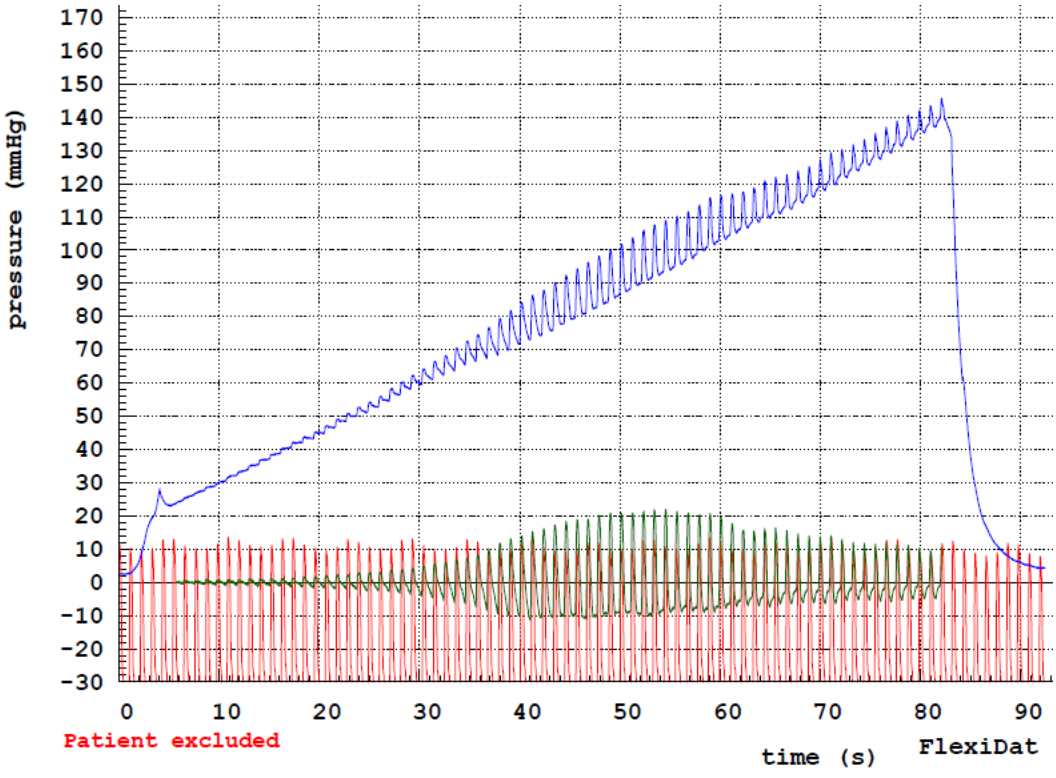
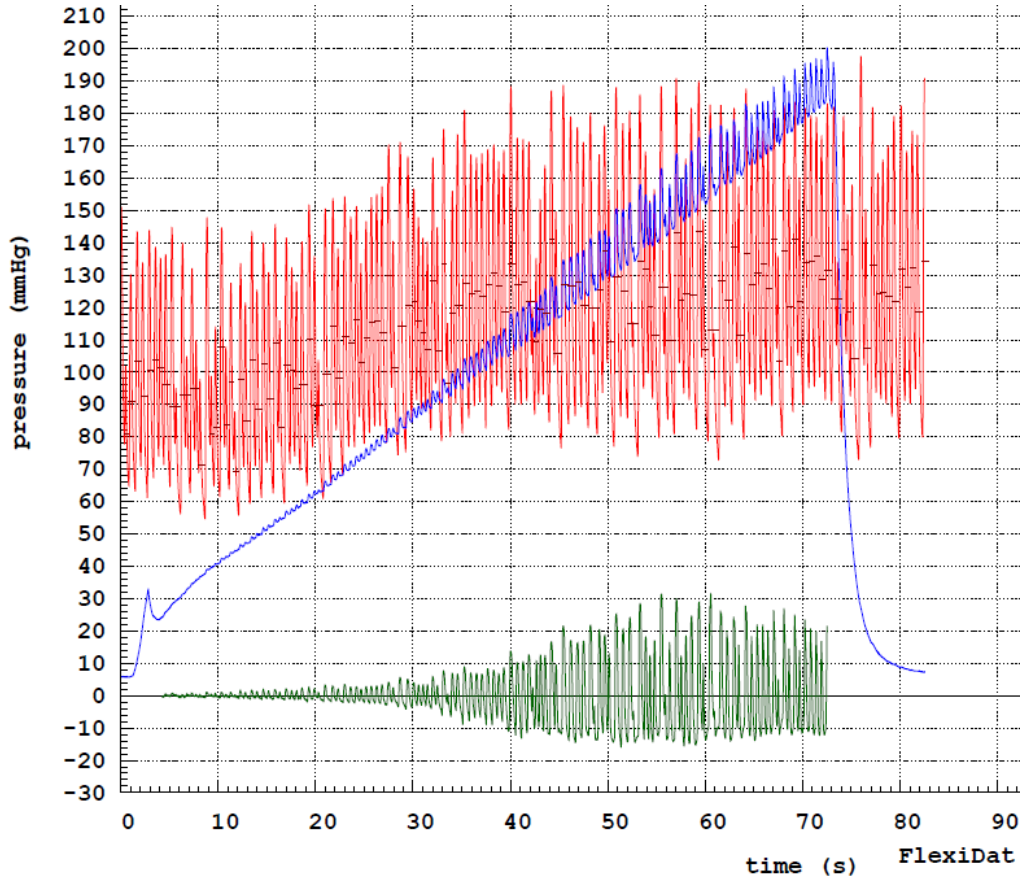


Figure S3a and S3b.

Exclusion of a 70-year-old female patient due to atrial fibrillation and varying invasive arterial blood pressure.



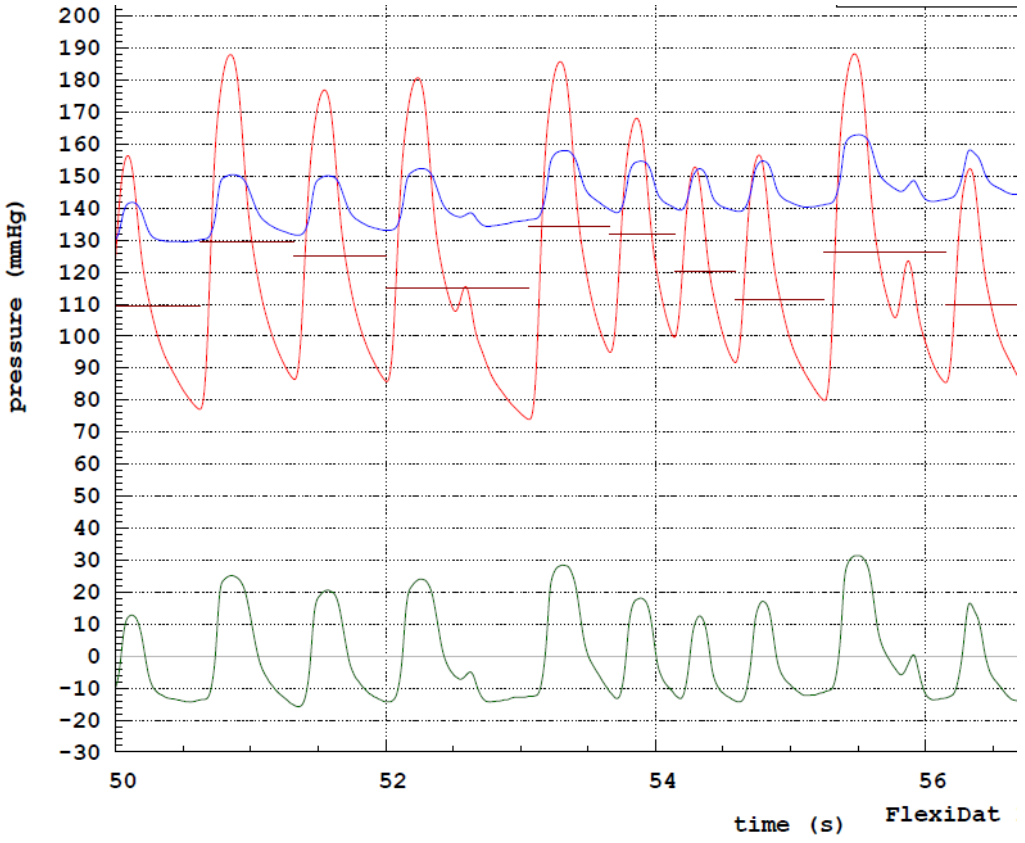
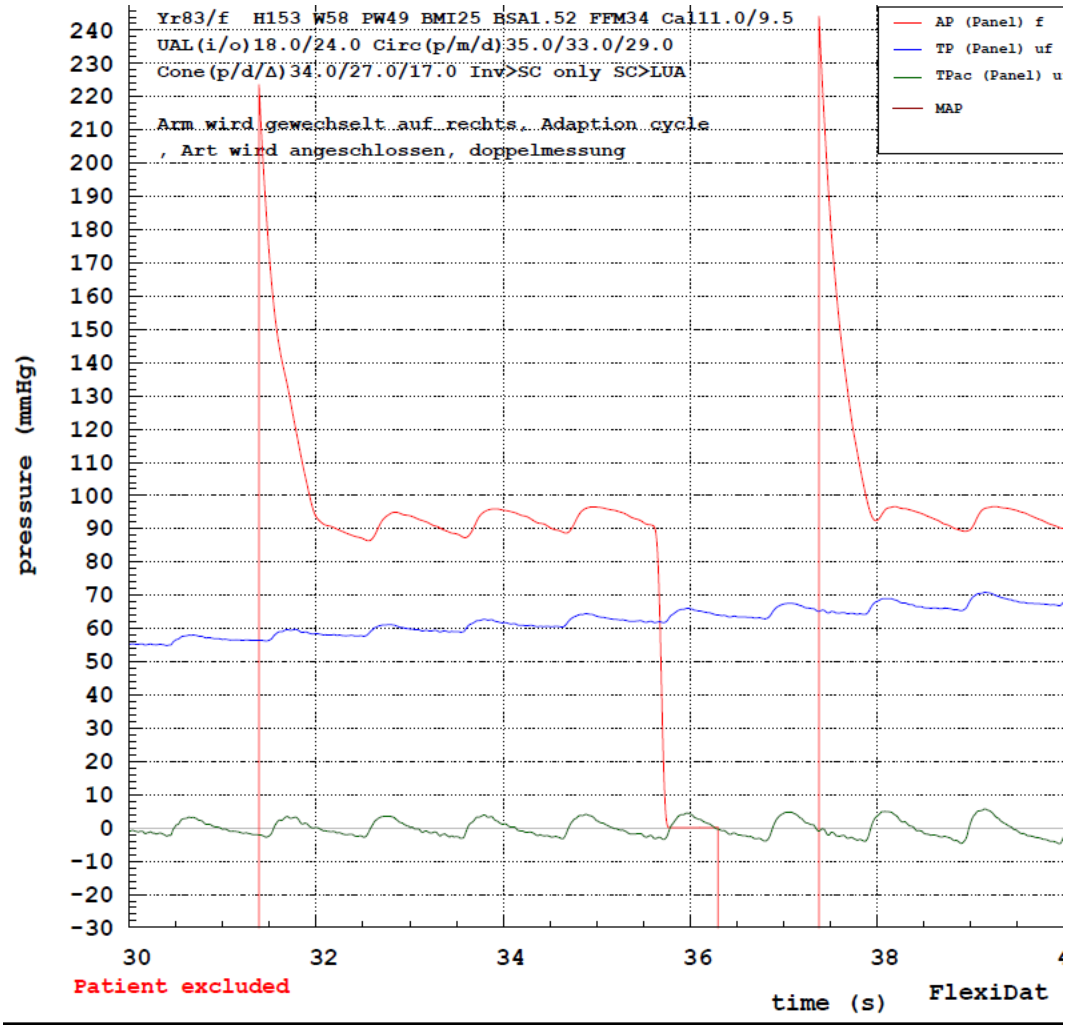


Figure S4.
Exclusion of an 83-year-old female due to defective electronic recording of invasive arterial blood pressure.



4. Exclusion of single paired measurements in included patients

Of the 110 patients included, 3102 paired data sets were available, which were analyzed by two experts according to predefined quality criteria (see 2. Offline data classification and evaluation). This quality check led to the further exclusion of 1215 paired measurements.

4.1. Invasive arterial blood pressure instability during measurement (457 measurements), Fig. S5
4.2. Overdamped invasive arterial blood pressure waveforms during measurement (213 measurements), Fig. S6
4.3. Technical failure of invasive blood pressure measurements (183 measurements), Fig. S7, Fig. S8
4.4. External artifacts or noise of high-fidelity cuff tissue pressure waves (168 measurements), Fig. S9
4.5. High-fidelity cuff monitor with malfunction (124 measurements)
4.6. Other reasons (70 measurements)

Figure S5.
Exclusion of single paired measurement in a 57-year-old male patient with invasive arterial blood pressure instability during the measurement (most common reason for exclusion, 457 of 1215 measurements). Hemodynamic instability was defined as slow drifts of MAP ≥ 10 mmHg or transient bumps, decrease, or increase in MAP ≥ 10 mmHg within 60s of measurement window.

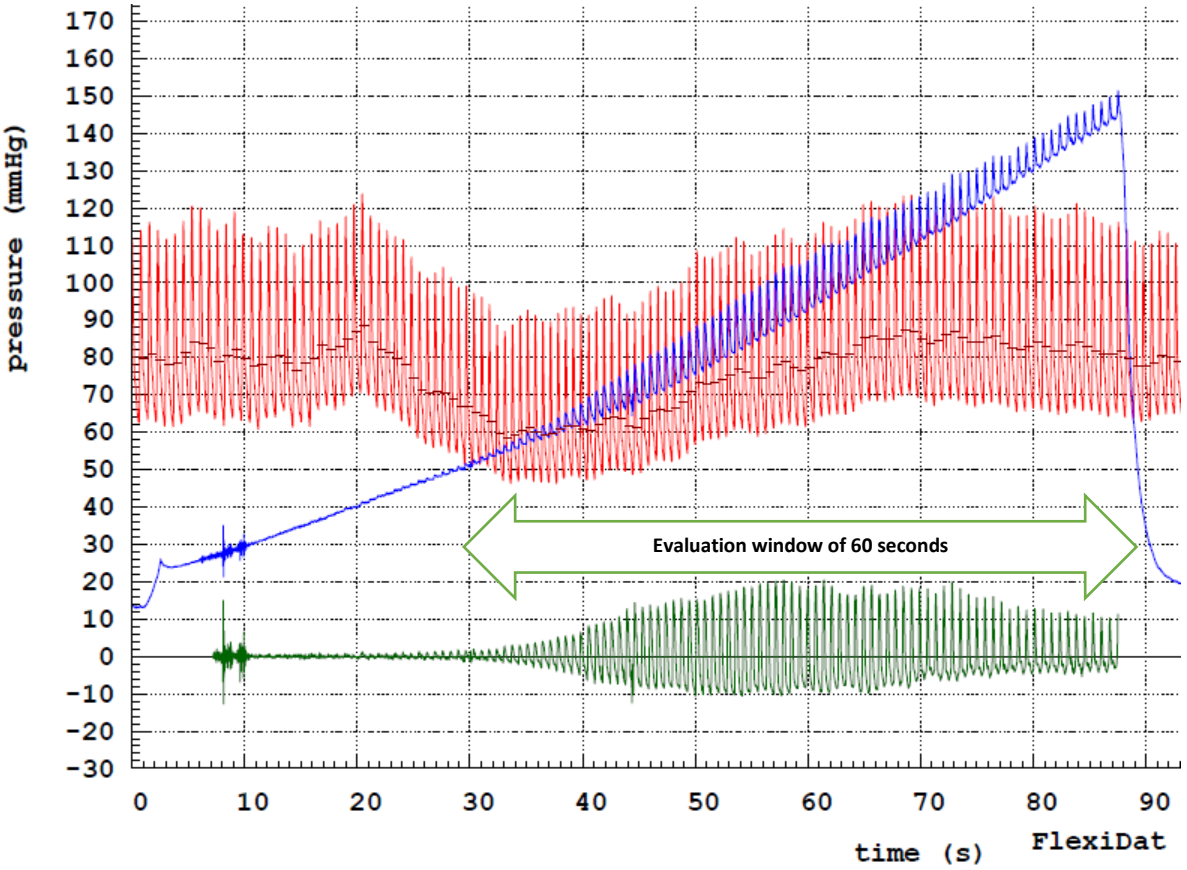


Figure S6.

Exclusion of single paired measurement in a 66-year-old female patient with overdamped invasive arterial blood pressure waveform. Of note, MAP was not affected by overdamping but SBP and DBP.

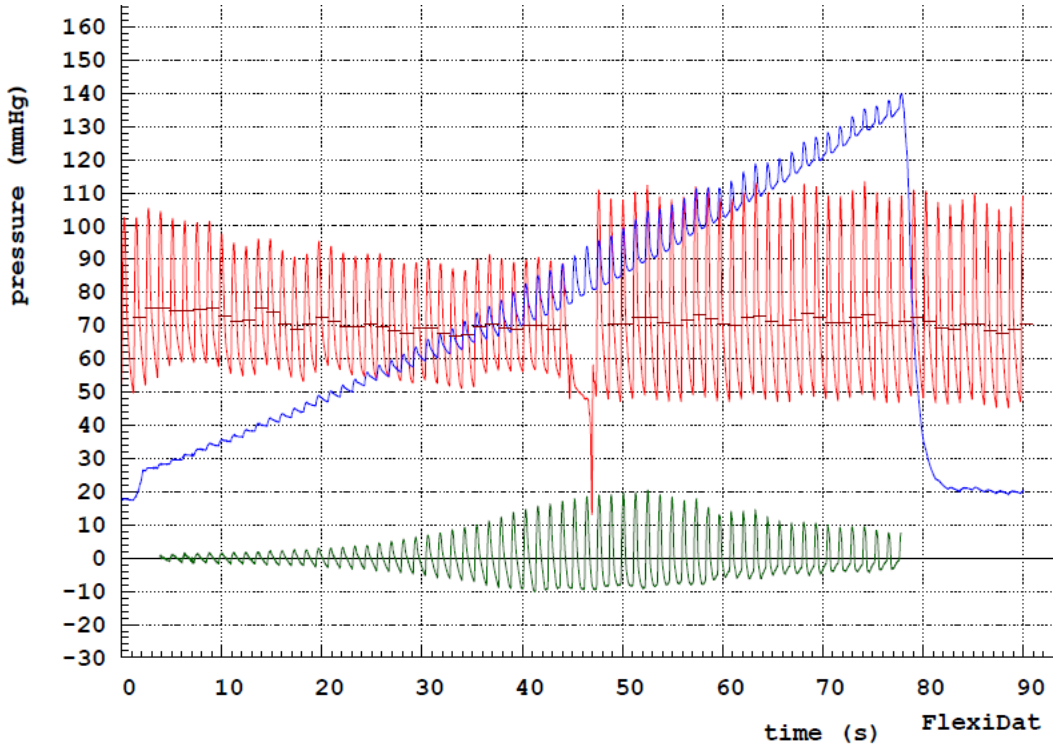


Figure S7.

Exclusion of single paired measurement in a 59-year-old male patient with invasive arterial blood pressure technical failure.

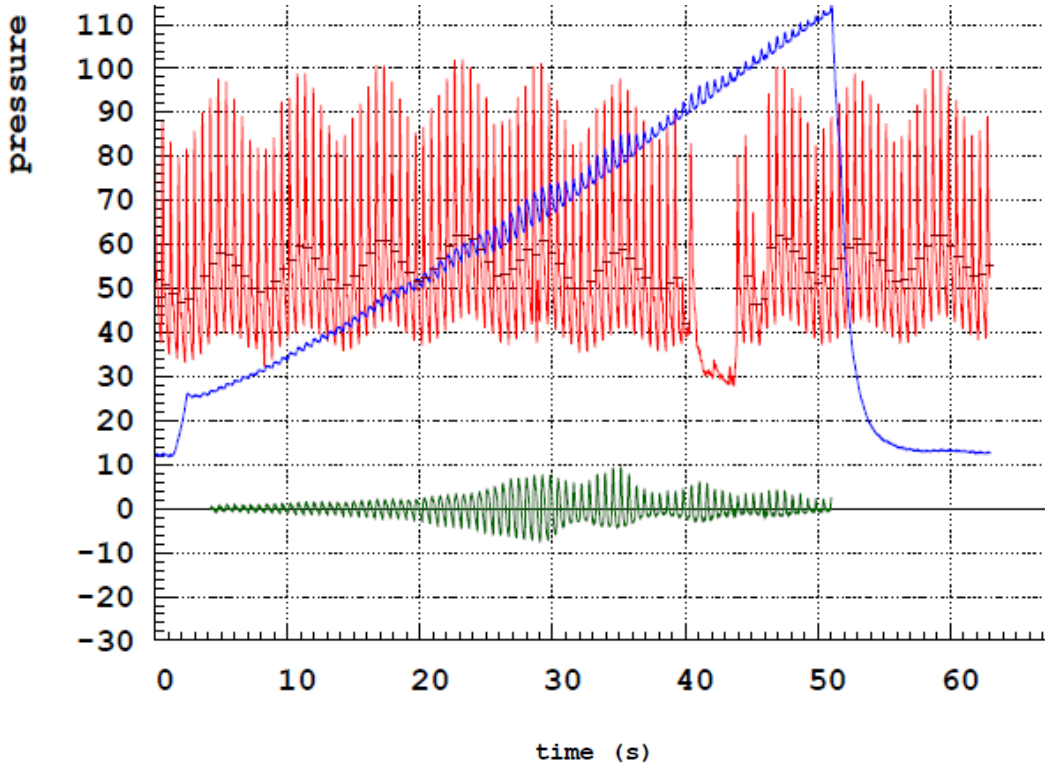


Figure S8.

Exclusion of single paired measurement in a 68-year-old male patient with invasive arterial blood pressure technical failure.

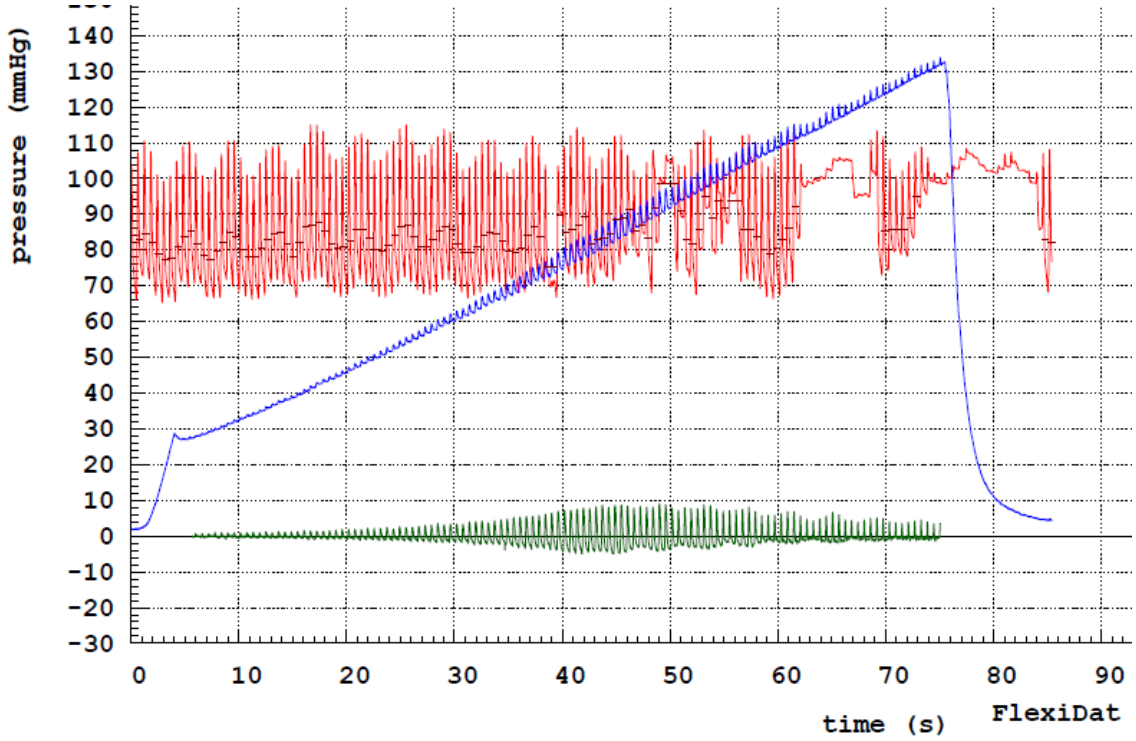
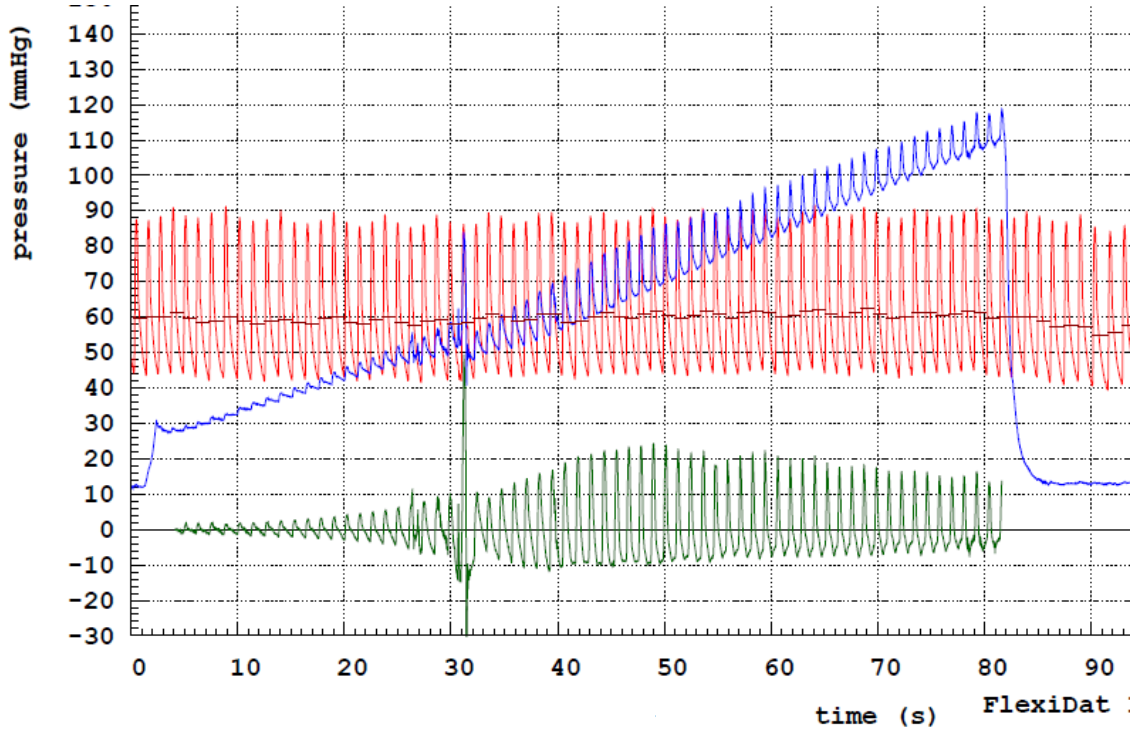


Figure S9.

Exclusion of single paired measurement in an 83-year-old female patient with external artifacts of high-fidelity cuff pressure waves caused by the surgeon leaning on high-fidelity cuff.



5. Descriptive statistical analysis

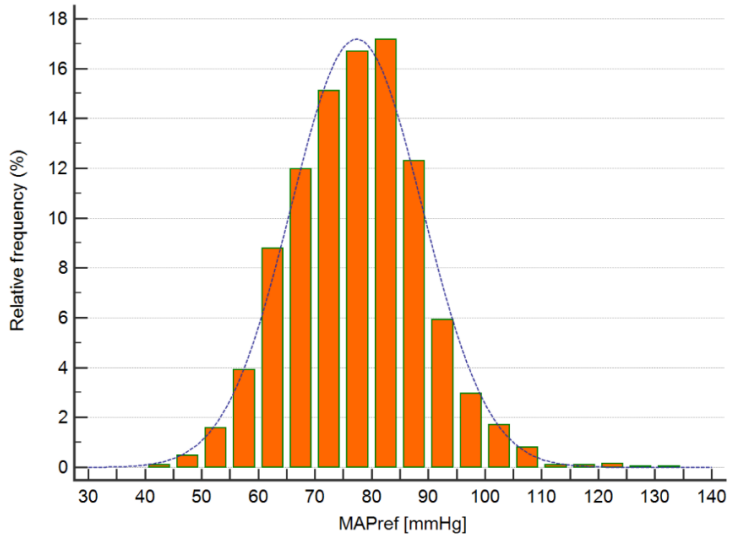
The descriptive analysis showed a high weight both for individual patients with many measurements and for invasive MAP between 75 and 85 mmHg (5.1) which is why we decided to select an equal number of measurements per patient that covered the measured pressure range each. In this way a homogeneous distribution of invasive MAP of the paired measurements was achieved (5.2).

5.1 Included paired measurements

Variable	Invasive mean blood pressure (MAPref) [mmHg]
Sample size	1887
Lowest value	44
Highest value	132
Arithmetic mean	77
95% CI for the Arithmetic mean	77 to 78
Median	77
95% CI for the median	77 to 78
Variance	135
Standard deviation	12
Relative standard deviation	0,15 (15%)
Standard error of the mean	0,27
Coefficient of Skewness	0,2704 (P<0,0001)
Coefficient of Kurtosis	0,5980 (P<0,0001)
Kolmogorov-Smirnov test[a] for Normal distribution	D=0,0252 reject Normality (P=0,0074)

[a] Lilliefors significance correction

Percentiles		95% Confidence interval
2,5	56	54 to 57
5	59	58 to 60
10	63	62 to 63
25	69	69 to 70
75	85	84 to 85
90	91	90 to 92
95	96	95 to 98
97,5	101	100 to 104



5.2. Selected paired measurements

Selection of an equal number of measurements (n=5) per patient that covered the range of all measured invasive MAP from 44 mmHg to 132 mmHg.

	Invasive mean blood pressure (MAPref) [mmHg]
Sample size	550
Lowest value	44
Highest value	132
Arithmetic mean	78
95% CI for the Arithmetic mean	77 to 79
Median	78
95% CI for the median	77 to 79
Variance	157
Standard deviation	13
Relative standard deviation	0,16 (16%)
Standard error of the mean	0,54
Coefficient of Skewness	0,4201 (P=0,0001)
Coefficient of Kurtosis	0,9091 (P=0,0012)
Kolmogorov-Smirnov test[a] for Normal distribution	D=0,0313 accept Normality (P>0.10)

[a] Lilliefors significance correction

Percentiles		95% Confidence interval
2,5	56	52 to 58
5	59	57 to 60
10	62	60 to 64
25	69	67 to 71
75	86	84 to 87
90	93	91 to 95
95	99	96 to 103
97,5	105	101 to 108