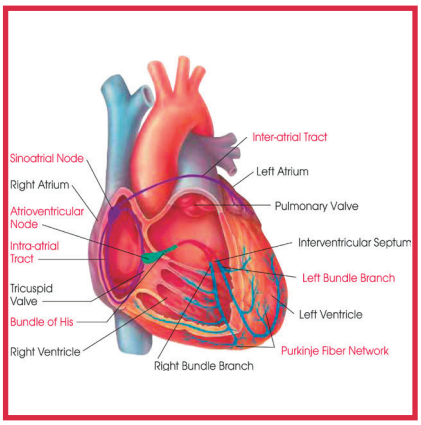
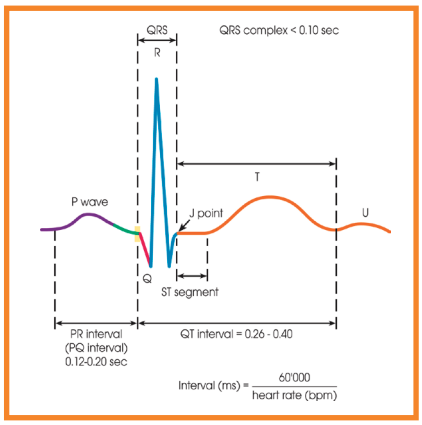
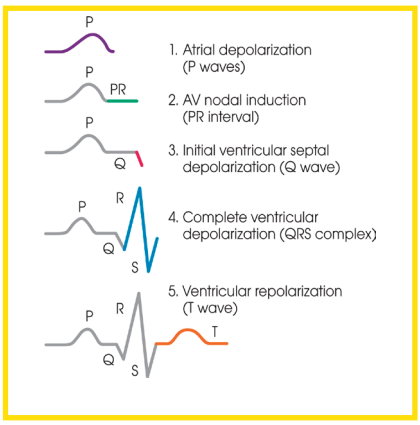
DESIGNED AND MANUFACTURED IN SWITZERLAND

ECG Measurements and Interpretation Programs







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Physician's Guide

SCHILLER

The Art of Diagnostics

Sales and Service Information

The SCHILLER sales and service centre network is world-wide. For the address of your local distributor, contact your closest SCHILLER subsidiary. In case of difficulty, a complete list of all distributors and subsidiaries is provided on our internet site:

www.schiller.ch

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CE 0123

SCHILLER AG bears the CE-0123 mark (Notified Body TÜV-SÜD Produkte Service GmbH, Ridlerstr. 65, 80339 Munich, Germany), indicating its compliance with the essential requirements of the Annex I of the Medical Device Directive 93/42/EE regarding safety, functionality and labelling. The requirements apply to patients, users and third persons who come into contact with this device within the scope of its intended use.

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1 Important notices

1.1 Disclaimer

The Information in this guide has been carefully checked for reliability; however no guarantee is given as to the correctness of the contents and SCHILLER AG makes no representations or warranties regarding the contents of this Guide. We reserve the right to revise this document and make changes in the specification of the product described within at any time without obligation to notify any person of such revision or change.

1.2 Physicians Responsibility

The Interpretation and Measurement program on the SCHILLER devices is provided for the exclusive use of qualified physicians or personnel under their direct supervision. The numerical and graphical results, and the interpretation of a recording must be examined with respect to the patients overall clinical condition. The recording preparation quality and the general recorded data quality, which could effect the report data accuracy, must also be taken into account. It is the physicians responsibility to make the diagnosis or to obtain expert opinion on the results, and to institute correct treatment if indicated

The information contained in this guide provides an explanation of the measurements and interpretation statements that can be obtained with a resting ECG recorded with the SCHILLER ECG devices. The measurement and the interpretation programs, developed over many years, provide one of the most accurate ECG analysis packages available on the market today.

Additional information about the accuracy of analysing ECG units from SCHILLER according to IEC/EN 60601-2-51, chapters 50, 51 and 56, is given in the document Statement of accuracy for analysing ECG units. This document (art. no. 2.530036) can be ordered at sales@schiller.ch.

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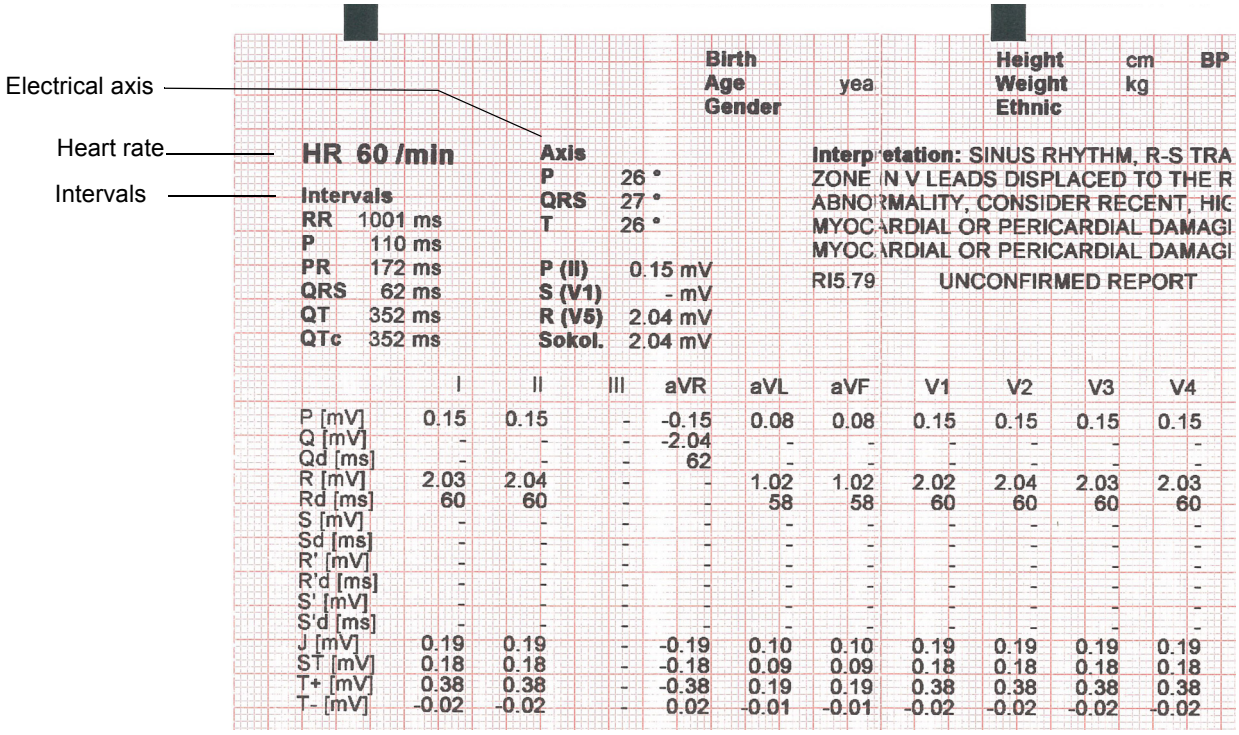
2 Definition of Terms

When an auto mode ECG is taken by the SCHILLER ECG device with the ECG Interpretation or Measurements option installed, the program documents various measurements derived from the ECG. This data forms the basis for the interpretation. The following pages define what the measurements are, and how they are derived.



2.1 Heart Rate (HR)

Heart rates (HR) from 30 - 250 beats per minute are measured.

Average heart rate (**HR**) calculated on the basis of the entire 10 second recording and shown as number of beats per minute.

2.2 Intervals

RR Average time interval between two consecutive QRS complexes.

P P Wave Duration: the time between the beginning of the first detected P-wave from all 12 averaged leads, to the end of the last detected P-wave from all 12 averaged leads.

PR PR interval: the period of time between the beginning of the first detected P-wave taken from all 12 averaged leads, and the beginning of the first detected Q-wave taken from all 12 averaged leads.

QRS The duration of the QRS complex taken from the beginning of the first detected Q-wave from all 12 averaged QRS complexes, to the end of the last S-wave from all 12 averaged QRS complexes.

QT Interval between the beginning of the first QRS (beginning of ventricular depolarisation) taken from all 12 averaged leads, and the end of the last T-wave (end of repolarisation phase) taken from all 12 averaged leads.

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QTC Normalised QT interval. As the QT interval is dependent on the heart rate it is often converted to the normalised QTC interval i.e. the QT interval that the patient would show at a heart rate of 60 / min. Usually, the QTC value is 390 ± 40 ms.

The conversion is according to Bazetts` formula:

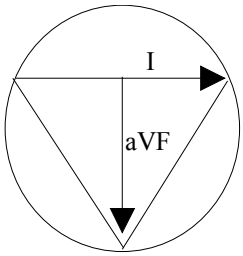
$$QTC = QT \times \sqrt{\frac{1000}{RR}}$$

All measurements are in milliseconds.

2.3 Electrical Axis

The measurement program on the SCHILLER devices calculates the axes on the basis of the maximum deflection of the relevant waves in leads I and aVF.

The electrical axes of the heart are determined separately for the P, QRS and T waves. They indicate the main spreading direction of the electrical vector in the *frontal plane*.



The following formula is used for the calculation:

$$\text{axis } a = \arctan\left(\frac{\text{Sum of max. vector (aVF)}}{\text{Sum of max. vector (I)}}\right)$$

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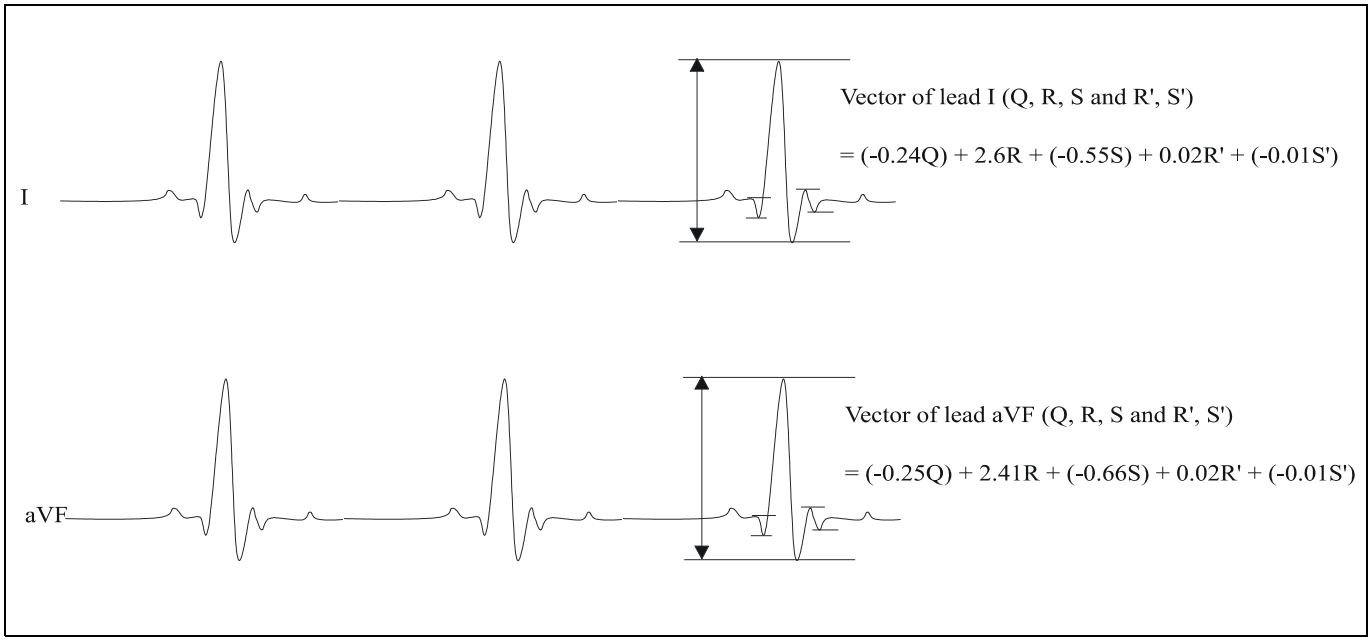
2.4 Example



Taking the example above we get:

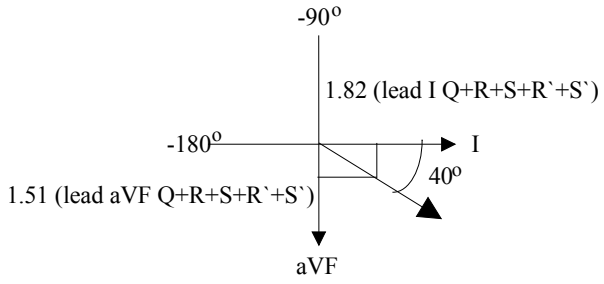
$$\text{axis a} = \arctan\left(\frac{\text{Sum of max. vector (aVF)}}{\text{Sum of max. vector (I)}}\right)$$

on the example printout given this is :

$$\text{axis a} = \arctan\left(\frac{Q(aVF) + R(aVF) + S(aVF) + R`(aVF) + S`(aVF)}{Q(I) + R(I) + S(I) + R`(I) + S`(I)}\right)$$

$$\text{axis a} = \arctan\left(\frac{(-0.25) + 2.41 + (-0.66) + 0.02 + (-0.01)}{(-0.24) + 2.60 + (-0.55) + 0.02 + (-0.01)}\right)$$

$$\text{axis a} = \arctan\left(\frac{1.51}{1.82}\right) = 40°$$



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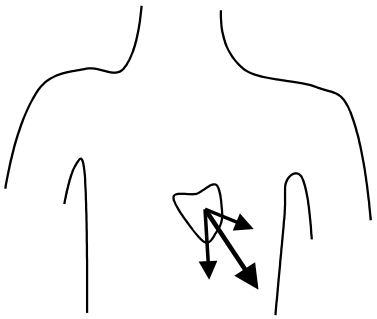

Normal Range	0° to 90°
Abnormal left axis deviation	-90° to -30°
Leftward axis	-30° to 0°
Rightward axis	+90° to + 110°
Abnormal right axis deviation	+110° to +180°
Abnormal right superior axis deviation	-90° to -180°

Large discrepancies may be found between two measurements with faint P and T waves. Also breathing and the position of the patient (recumbent / standing) can result in changes in the electrical axes.

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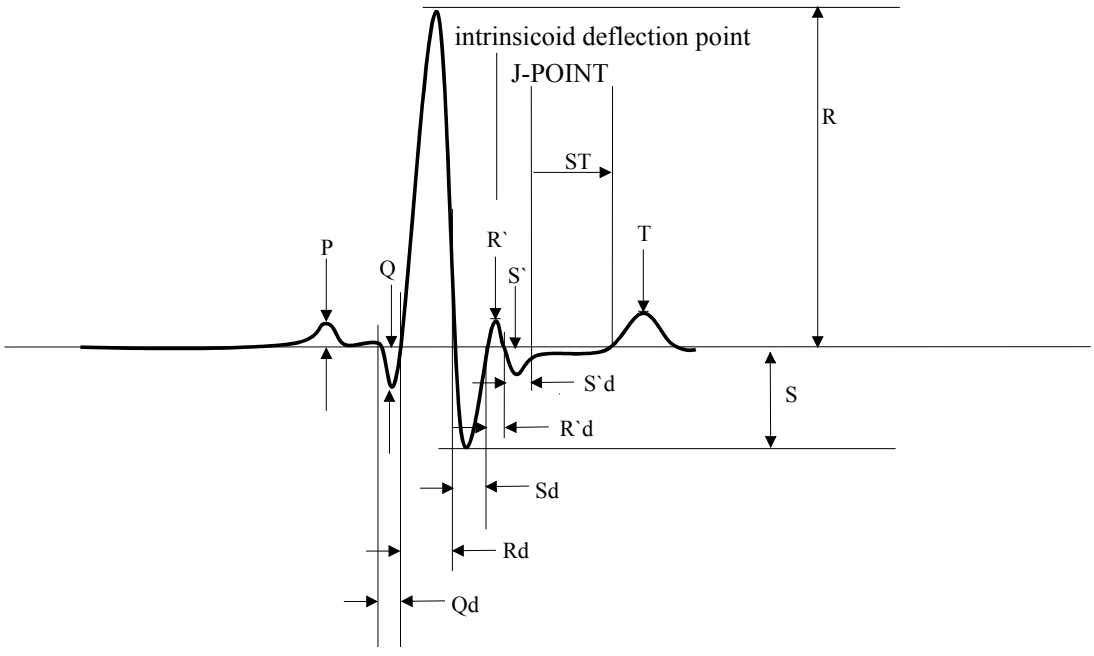
3 Measurements

The measurement program on the ECG device provides a table with lead-specific measurement results. In 12 columns i.e. one for each lead, the amplitude values of P, Q, R, S, T and R', S', T' waves, the J point and the ST integral are listed in millivolts. The amplitude measurements relate to a reference value that corresponds to the signal value immediately before the beginning of the QRS. For P measurement the zero value at Pon is determined as a mean value in an interval from Pon -20 ms to Pon inclusive. The duration of the Q, R, S, R' and S' waves are given in milliseconds (rounded to 2 ms). The amplitudes are given in mV (rounded to 0.01 mV).

Parameter	Description	Unit
P	amplitude of P wave	mV
Q	amplitude of Q wave	mV
Qd	duration of Q wave	ms
R	amplitude of R wave	mV
Rd	duration of R wave	ms
S	amplitude of S wave	mV
Sd	duration of S wave	ms
R'	amplitude of R' wave	mV
R'd	duration of R' wave	ms
S'	amplitude of S' wave	mV
S'd	duration of S' wave	ms
J	amplitude of J point	mV
ST	ST integral: averaged amplitude of the ST segment (from the J point to half the distance between the J-point and max. T wave)	mV
T	amplitude of the T wave	mV
T'	amplitude of the T' wave (in case of biphasic T wave)	mV



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4 Interpretation statements

4.1 Statement of Confidence

The ECG Interpretation program on the ECG device is designed to assist the physician in reading and evaluating an ECG printout. It was developed in cooperation with leading cardiologists and evolved over many years; extensive checking has been carried out using, among others, the CSE[1] diagnostic data base. However, no program is completely infallible and interpretative standards and criteria can and do vary between cardiologists and programs. Never rely solely on the statements given with any computerised interpretation program; a machine cannot deliver a complete diagnosis on the basis of the ECG alone without a considerable amount of additional information. Always obtain physician's confirmation.

⚠ CAUTION

- ▲ The statements given with this or any interpretation program do not replace a detailed report by the physician. The comprehensive clinical diagnosis of a patient is the physician's responsibility and privilege.
- ▲ The ECG evaluation should always be systematic and conducted in a predetermined order.
- ▲ Before each ECG evaluation, verification that the recording was carried out correctly must be made.
- ▲ It should also be determined whether the patient received any heart-active medication (digitalis, beta-blockers, anti-arrhythmics, diuretics etc.) before the recording that could affect the recording.
- ▲ Examine the ECG first in accordance with the procedure given in chapter 4.2, then read the interpretation statements.

4.2 Procedure for Evaluation

The following procedure is recommended for evaluation:

1. Determine rhythm or rhythm disturbances.
2. Determine heart rate.
3. Check duration of P, PR, QRS and QT.
4. Determine electrical axis in extremity leads and evaluate pericardial leads (R/S ratio, transitional zone etc.).
5. Systematic examination of P, Q, R, S, T waves and ECG segments (ST segment etc.).
6. Brief description of exceptional and abnormal signs within each single section of the waveform.
7. Overall evaluation.

In this procedure, you are supported by the ECG interpretation program on the ECG device. It supplies the necessary measurement data and suggestions for interpretation.

For an efficient evaluation of interpretation statements it is important that the patient data has been entered, especially patient's age and sex as well as any medication.

Each explanation is accompanied by one of the following statements:

- Normal ECG
- Otherwise normal ECG
- Borderline ECG
- Possibly abnormal ECG
- Abnormal ECG

1. Common Standards for Quantitative Electrocardiology (concerted action Project II.1.1.2.)

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The ECG statement that is given for each interpretive diagnostic statement is given with the diagnostic statements in the following pages.

If more than one interpretation statement is applicable, only the general classification statement with the highest importance level is given on the printout.

4.3 Statements Indicating Level of Confidence

In some interpretation statements, information is provided to indicate the degree of confidence in the diagnosis. The statements and the level of confidence associated with the statement, are as follows:

Statement	Level of Confidence
Cannot Rule Out...	c. 15 %
Possible ...	c. 35 %
Consider...	c. 50 %
Consistent with ...	c. 80 %

4.4 Pediatric ECG Interpretation

A special section at the end of this book details the interpretation of paediatric ECGs. The interpretation program on the ECG devices automatically distinguishes between adults and pediatric by using the date of birth as a basis for computing the ECG interpretation.

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5 Rhythm Statements

5.1 Atrial premature complex(es)

One or several premature beats of the same shape as the predominant beats were detected in the absence of atrial fibrillation and the preceding RR interval is < 80 % of the RR mean and the sum of the following RR interval is > 120 % of RR mean.

(OTHERWISE NORMAL ECG)

Bigeminy will appear in addition to this statement if at least three supraventricular extrasystoles are detected, each separated from the preceding one by a single predominant beat.

Trigeminy will appear in addition to this statement if at least three supraventricular extrasystoles are detected, each separated from the preceding one by two predominant beats.

(ABNORMAL ECG)

5.2 Ventricular premature complex(es)

One or several premature beats, differing in shape and size from the predominant beats were detected and the preceding RR interval is < 90 % of the RR mean and the sum of the following RR interval is > 120 % of RR mean.

(ABNORMAL ECG)

Bigeminy will appear in addition to this statement if at least three ventricular extrasystoles are detected, each separated from the preceding one by a single predominant beat

Trigeminy will appear in addition to this statement if at least three ventricular extrasystoles are detected, each separated from the preceding one by two predominant beats.

(ABNORMAL ECG)

5.3 Atrial escape complex(es)

A beat of the same shape as the predominant beats is detected after a pause longer than 1.8 times of the predominant RR interval preceded by one or several beats of the same shape as the predominant beats in the absence of atrial fibrillation.

(OTHERWISE NORMAL ECG)

5.4 Ventricular escape complex(es)

A beat differing in shape and size from the predominant beats is detected after a pause longer than 1.8 times of the predominant RR interval preceded by one or several beats differing in shape and size from the predominant beats in the absence of atrial fibrillation.

(ABNORMAL ECG)

5.5 Interpolated atrial premature complexes

Preceding RR interval <80 % of mean RR and the sum of the preceding and following RR interval ≤ 120 % of RR mean. Beat of the same shape and size as the predominant beats.

(OTHERWISE NORMAL ECG)

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5.6 Interpolated ventricular premature complexes

Preceding RR interval <90 % of mean RR and the sum of the preceding and following RR interval ≤ 120 % of RR mean. Beat of differing shape than the predominant beats.

(ABNORMAL ECG)

5.7 Complexes with aberrant intraventricular conduction

One or several beats were detected differing in shape and size from the predominant beats but occurring in time, i.e. separated from the preceding and following beats by the predominant RR interval. Preceding RR interval > 90 % of the RR mean or the sum of the preceding RR interval and following RR interval ≤180 % of RR mean.

(ABNORMAL ECG)

5.8 Sinus rhythm

A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the RR intervals between the predominant beats was no greater than 15 %.

(NORMAL ECG)

5.9 Sinus arrhythmia

A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the RR intervals between the predominant beats was greater than 15 % in at least 3 intervals and no interpolated premature atrial complexes, premature atrial complexes, atrial escape complexes or bigemy or trigemy were detected.

(OTHERWISE NORMAL ECG)

5.10 Sinus bradycardia

A P wave was detected in the averaged ECG cycle, and the heart rate was less than 50 beats per minute.

(OTHERWISE NORMAL ECG)

As above but heart rate ≤ 40 beats (ABNORMAL ECG)

5.11 Sinus tachycardia

A P wave was detected in the averaged ECG cycle, and the heart rate was greater than 100 beats per minute.

(OTHERWISE NORMAL ECG)

5.12 Supraventricular rhythm

A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the RR intervals between the predominant beats was no greater than 15 % but frontal P axis <-20° or > 100°

(POSSIBLY ABNORMAL ECG)

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5.13 Supraventricular arrhythmia

A P wave was detected in the averaged ECG cycle, the heart rate ranged from 50 to 100 beats per minute, and the difference in the duration of the RR intervals between the predominant beats was greater than 15 % but frontal P axis <-20° or > 100°

(OTHERWISE NORMAL ECG)

5.14 Supraventricular tachycardia

The heart rate was greater than 130 beats per minute and the QRS duration < 140 ms.

(OTHERWISE NORMAL ECG)

5.15 Junctional rhythm

No P wave detected in the averaged ECG cycle, QRS duration ≤ 140 ms, heart rate ≤ 60 / min. The difference in the duration of the RR intervals between the predominant beats was < 15 %.

(ABNORMAL ECG)

5.16 Accelerated junctional rhythm

No P wave detected in the averaged ECG cycle, QRS duration ≤ 140 ms, heart rate ≤ 130 / min. (child up to 200). The difference in the duration of the RR intervals between the predominant beats was < 15 %.

(ABNORMAL ECG)

5.17 Regular rhythm, no P wave found/ventricular rhythm 40<HR<100

No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was >140 ms. The heart rate was between 40 and 100 beats per minute. There was less than 15 % difference in the duration of the RR intervals between the predominant beats.

(POSSIBLY ABNORMAL ECG)

5.18 Idioventricular rhythm

No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was greater than 140 ms. The heart rate was less than or equal to 40 beats per minute, and there was less than 15 % difference in the duration of the RR intervals between the predominant beats.

(ABNORMAL ECG)

5.19 Ventricular tachycardia

No P wave was detected in the averaged ECG cycle and the QRS duration of the predominant beats was greater than 140 ms. The heart rate was greater than or equal to 100 beats per minute, and there was less than 15 % difference in the duration of the RR intervals between the predominant beats.

(ABNORMAL ECG)

5.20 Atrial fibrillation

No P wave was detected in the averaged ECG cycle, the heart rate was less than 100 beats per minute, and there was at least 15 % difference in the duration of at least one RR interval between the predominant beats.

(ABNORMAL ECG)

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5.21 Atrial flutter

Rate of P wave ≥ 160 min., amplitude > 175 µV in one of the leads II, V1, or V2. Rate of P wave is different from the QRS rate.

(ABNORMAL ECG)

5.22 Atrial fibrillation / flutter with rapid ventricular response

No P wave was detected in the averaged ECG cycle, the heart rate was equal to or greater than 100 beats per minute, and there was at least 15 % difference in the duration of at least one RR interval between the predominant beats.

(ABNORMAL ECG)

5.23 Second / third degree AV-Block

P wave with a higher rate than the QRS rate in beats / min. have been detected. Most PP intervals lie within 15 % of normal median or double median. Minimum mean PP > 500 ms; minimum PP > 375 ms

(ABNORMAL ECG)

5.24 Pacemaker spikes noted

More than two typical pacemaker spikes were detected in at least two leads of the original ECG data recorded over 10 seconds.

(ABNORMAL ECG)

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6 Electrical Axes

The electrical axis is computed on the basis of the algebraic sum of the amplitudes and deflections of the QRS complex in leads I and aVF. The possible findings with their corresponding ranges are as follows:

6.1 Abnormal left axis deviation

≤ -90° to ≤ -30°

ABNORMAL ECG

6.2 Leftward Axis

< -30° to ≤ 0°

OTHERWISE NORMAL ECG

6.3 Rightward Axis

< +90° to ≤ +110°

OTHERWISE NORMAL ECG

6.4 Abnormal right axis deviation

< +110° to ≤ +180°

ABNORMAL ECG

6.5 Abnormal right superior axis deviation

< -90° to ≤ -180°

ABNORMAL ECG

6.6 Indeterminate axis

The algebraic sum of the deflections of the QRS complex in leads I and aVF ranged between -0.15 mV and +0.15 mV.

(BORDERLINE ECG)

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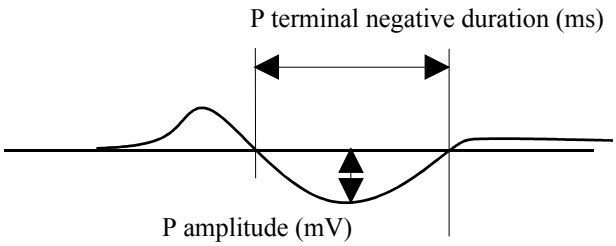
7 Atrial Activity Statements

7.1 Definition of P terminal force



P Terminal Force = (P negative amplitude) * (P terminal negative duration) mVms

7.2 Possible left atrial abnormality

P terminal negative force (maximal negative amplitude of P times terminal negative phase of P) in V1 is -6 mVms > P terminal force ≥ -8 mVms. Terminal negative phase > 60 ms, max. negative P amplitude in V1 ≤ -0.1 mv.

(POSSIBLY ABNORMAL ECG)

7.3 Left atrial abnormality

P terminal negative force (maximal negative amplitude < -0.1 mV times terminal negative phase of P) in V1 is -8 mVms > P terminal force. Terminal negative phase > 60 ms, maximum negative P amplitude in V1 is ≤ -0.1 mv.

(ABNORMAL ECG)

7.4 Right atrial abnormality

For the detection of a right atrial abnormality (P duration ≥ 140 ms), points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

P-amplitude in II:	1 point if 0.25 mV ≤ P amplitude < 0.3 mV.
	2 points if the P amplitude ≥ 0.3 mV.
P-amplitude in III:	1 point if 0.25 mV ≤ P amplitude < 0.3 mV.
	2 points if the P amplitude ≥ 0.3 mV.
P-amplitude in aVF:	1 point if 0.25 mV ≤ P amplitude < 0.3 mV.
	2 points if the P amplitude ≥ 0.3 mV.

The test for right atrial abnormality yielded at least three points.

(POSSIBLY ABNORMAL ECG)

7.5 Bi-atrial abnormality

The conditions for (possible) left atrial abnormality and right atrial abnormality (at least two points in the test) have been satisfied.

(ABNORMAL ECG)

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7.6 Prolonged P-R interval

The duration of the P-R interval was longer than:

$$(21) \times (\sqrt[4]{10 \times \mathrm{RRinterval}})) + (20)[\mathrm{ms}]$$

or 220 ms, whichever is less with a lower limit of 205 ms

(ABNORMAL ECG)

7.7 Prolonged P duration

The duration is longer than 140 ms.

(BORDERLINE ECG)

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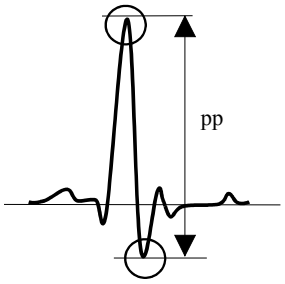
8 ECG Voltage Statements

8.1 Low limb lead voltage

The sum of the peak-to-peak QRS amplitudes in leads I, II and III was 1.5 mV or less, and the difference between the maximal QRS amplitudes in V4-V6 and the minimal QRS amplitudes in V1-V3 was > 0.7 mV.

(BORDERLINE ECG)

8.2 Low voltage



The sum of the peak-to-peak QRS amplitudes in leads I, II and III is 1.5 mV or less, **and** the **difference** between the **maximal** QRS amplitudes (= max R, R') in V4-V6 and the **minimal** QRS amplitudes (= min Q, S, S') in V1-V3 is 0.7 mV or less.

(Σ (ppI; ppII, ppIII) $\leq$ 1.5 mV**) and**

((the **maximal** amplitude (R, R') from one of the leads V4, V5, V6) **-**

the **minimal** amplitiude (Q, S, S') from one of the leads V1, V2, V3) $\leq$ 0.7 mV**)**

(ABNORMAL ECG)

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9 Blocks

9.1 Right bundle branch block

The total duration of QRS was at least 130 ms. The R/S ratio in lead V2 was greater than 1, or an S wave deeper than -0.20 mV was detected in leads I and V6. In lead V1 or lead V2 a QRS complex of the (Q)RSR' type was found. Time of occurrence of the intrinsicoid deflection in V1 and V2 > 60 ms after QRS onset.

(ABNORMAL ECG)

9.2 Incomplete right bundle branch block

The total duration of QRS was shorter than 130 ms. In lead V1 or lead V2 a notched QRS complex or a QRS complex of the RSR' type was detected. Time of occurrence of the intrinsicoid deflection in V1 and V2 > 60 ms after QRS onset.

(OTHERWISE NORMAL ECG)

9.3 Left bundle branch block

The total duration of QRS was at least 130 ms. The R/S ratio in lead V2 was less than 1. If an S wave was found in leads I and V6, it was not deeper than -0.2 mV and the R/S ratio was ≥ 1. The Q wave amplitude in either lead I or lead V6 was ≥ -0.09 mV and mean absolute spatial velocity in the second third of the QRS < 58.5 mV/s

(ABNORMAL ECG)

9.4 Incomplete left bundle branch block

Same as left bundle branch block, except that the total duration of QRS was shorter than 130 ms and longer than or equal to 120 ms.

(POSSIBLY ABNORMAL ECG)

9.5 Nonspecific bundle branch block

The total duration of QRS was at least 130 ms. The criteria for left bundle branch block, right bundle branch block, left anterior or left posterior fascicular block were not fulfilled.

(ABNORMAL ECG)

9.6 Nonspecific intraventricular delay

The total duration of QRS was shorter than 130 ms but longer than or equal to 120 ms. The criteria for incomplete left bundle branch block, incomplete right bundle branch block, left anterior or left posterior fascicular block were not fulfilled.

(BORDERLINE ECG)

9.7 Left anterior fascicular block

No Q wave was present in lead aVF, i.e. the ventricular depolarisation started in a downward direction. The R/S ratio in lead aVF was 0.6 or less, and the electrical axis ranged between -30 and -120 degrees. An S wave with an amplitude of -0.25 mV must be present in lead V6. QRS duration ≤120 ms but may be longer in the presence of RBBB.

(ABNORMAL ECG)

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9.8 Left posterior fascicular block

The electrical axis ranged between +115° and +180°. The Q wave amplitudes in II, III and aVF were ≤–0.02 mV, and the Q durations in III, aVF were ≤ 40 ms. The R or R' amplitude in II was ≥0.8 mV, and in III ≥1.0 mV. QRS duration ≤120 ms but may be longer in the presence of RBBB.

(ABNORMAL ECG)

9.9 Bifascicular block

A left anterior fascicular block or a left posterior fascicular block occurred together with a right bundle branch block.

(ABNORMAL ECG)

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10 QRS Abnormality Statements

The program looks for signs of myocardial damage/infarction in a three steps approach:

- first the vectorcardiogram, constructed out of the 12 lead electrocardiogram (X=17/16*V6,Y=9/16(II+III), Z=(2*V6-25*V2)/54), is searched for irregularities indicative of myocardial damage;
- second the repolarisation is examined for concomitant abnormalities
- third the ECG is searched for corresponding diagnostic Q/QS waves.

If only the first step yields a positive result, the modifier 'cannot rule out' is put out; if the first two steps result in a positive finding, the modifier 'consider' is used. If all three steps yield a positive result, the modifier 'consistent with' is attached to the finding of myocardial damage/infarct.

CANNOT RULE OUT is substituted by **CONSIDER** in the following statements if in addition to the QRS contour abnormality pathognomonic inverted T waves were detected in appropriate leads, i.e.

- I and aVF for inferior localisation
- V1, V2 and V3 for anteroseptal localisation
- V4, V5 and V6 for anterolateral localisation
- and aVL for lateral localisation

10.1 QRS (T) contour abnormality, cannot rule out anteroseptal myocardial damage

There was a pathological start of the ventricular depolarisation. The initial momentary QRS vectors were directed backward and mostly to the left, and remained in this direction during the greater part of the ventricular depolarisation, instead of remaining directed forward for the first 30 ms then turning backwards and to the left.

(BORDERLINE ECG)

10.2 QRS (T) contour abnormality, cannot rule out anterolateral myocardial damage

The ventricular depolarisation started normally, the initial momentary QRS vectors being directed forward and to the right. However, instead of then turning to the left and backwards, the momentary QRS vectors turned further to the right and backwards.

(BORDERLINE ECG)

10.3 QRS (T) contour abnormality, cannot rule out lateral myocardial damage

The ventricular depolarisation started normally, the initial momentary QRS vectors being directed forwards and to the right. However, instead of then turning to the left and backwards, the momentary QRS vectors remained directed forwards and more to the right than normal, i.e. the turn to the left was postponed.

(BORDERLINE ECG)

10.4 QRS (T) contour abnormality, cannot rule out inferior myocardial damage

The initial 10 to 20 ms momentary QRS vectors were directed upward, which is still normal, but instead of turning immediately downwards, the momentary QRS vectors remained directed upward for at least the first 40 ms of the ventricular depolarisation and often remained directed upwards during the greater part of the ventricular depolarisation.

(BORDERLINE ECG)

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11 Myocardial Infarction Statements

A diagnosis of myocardial infarction requires the detection of at least one pathognomonic Q or QS wave (Q/QS), i.e. a Q-wave which measures at least 25 % of the amplitude of the following R wave, and at least 30 µV, in leads I, II, aVL, aVF, or V1 to V6, and Q duration ≥ 30 ms.

The ECG interpretation program enables the detection of myocardial infarctions within the following areas:

septal	Q/QS in V2
anteroseptal	Q/QS in at least two of the leads V1 to V3.
anterior	Q/QS in V4 only, or Q/QS in V4 in combination with Q/QS in any other lead V1 to V3 regardless of Q in V5, V6.
anterolateral	Q/QS in either V5 or V6, or Q/QS in at least two of the leads V4 to V6.
lateral	Anterolateral and Q/QS in I and/or aVL
high lateral	Q/QS in I and aVL
inferolateral	Q/QS in II and/or aVF and Q/QS in V6
inferior	Q/QS in II and/or aVF

A diagnosis of myocardial damage will be replaced by a diagnosis of myocardial infarction if a Q/QS was detected. The patient however must be at least 30 years old otherwise INFARCT will be substituted by MYOCARDIAL DAMAGE.

If only one Q/QS was detected in a certain area, the following diagnosis will appear:

11.1 QRS (T) contour abnormality, consider ...infarct

If more than one Q/QS was detected in a certain area, the following diagnosis will appear:

11.2 QRS (T) contour abnormality, consistent with....infarct

Exception: The septal location is always associated with „cannot rule out"'.

When a diagnosis of **myocardial infarction** is proposed, the program endeavours to determine its age:

„**Probably old**"	will appear when one ST elevation in resp. leads is detected
„**Possibly recent**"	will appear if at least two ST elevations in resp. leads were detected
„Age undetermined"	will appear in all other cases when no specific ST and T changes were detected in the leads defining the infarct localisation. No ST elevations in resp. leads.

A diagnosis of myocardial infarction will always have the classification

ABNORMAL ECG

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12 ST-T Morphology Statements

ST-T Morphology is not diagnosed when RVH and repolarisation abnormality, LVH and repolarisation abnormality is detected or in the case of RBBB; LBBB or NSIB.

12.1 ST-T Elevation, consider acute anterior infarct

ST elevation in leads V1 to V6 or aVL, I, above sex/age- and lead-dependant threshold in at least 2 contiguous leads.

(ABNORMAL ECG)

12.2 ST-T Elevation, consider acute inferior infarct

ST elevation in leads II, aVF, III $\geq$ 0.1 mV in at least 2 contiguous leads.

(ABNORMAL ECG)

12.3 ST-T Depression, consider acute posterior infarct

ST depression in leads V1 to V3 above lead-dependent threshold in at least 2 contiguous leads.

(ABNORMAL ECG)

12.4 ST-T Depression, consider acute subendocardial infarct

ST depression in leads V4 to V6 $\geq$ 0.1 mV in at least 2 contiguous leads. Not diagnosed when LVH with repolarisation abnormality or old myocardial infarction is detected

(ABNORMAL ECG)

12.5 ST abnormality, possible anteroseptal subendocardial injury

ST depressed by at least 0.25 mV in at least one of leads V2 or V3, and no QRS signs of an anteroseptal myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.6 ST abnormality, possible anterior subendocardial injury

ST depressed by at least 0.25 mV in other precordial lead combinations than those typical for anteroseptal and anterolateral injuries, and no QRS signs of an anterior myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.7 ST abnormality, possible anterolateral subendocardial injury

ST depressed by at least 0.25 mV in at least one of leads V4, V5 and V6, and no QRS signs of myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.8 ST abnormality, possible lateral subendocardial injury

ST depressed by at least 0.25 mV in leads V5 or V6, and at least 0.15 mV in leads I and aVL, and no QRS signs of a lateral myocardial injury or infarct were detected.

(ABNORMAL ECG)

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12.9 ST abnormality, possible high lateral subendocardial injury

ST depressed by at least 0.15 mV in leads I or aVL, and no QRS signs of a high lateral myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.10 ST abnormality, possible inferior subendocardial injury

ST depressed by at least 0.15 mV in leads II and aVF, and no QRS signs of an inferior myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.11 ST abnormality, possible inferolateral injury

ST depressed by at least 0.15 mV in leads II and aVF, and at least 0.25 mV in V6, and no QRS signs of an inferior myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.12 Nonspecific ST depression

ST < -0.05 mV and > -0.1 mV and no other abnormality or ST depressions mentioned above were detected.

(BORDERLINE ECG)

12.13 ST & T abnormality, consider anteroseptal ischemia or right ventricular strain

ST depressed by 0.05 to 0.09 mV with T biphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, biphasic or negative in at least one of leads V1, V2 and V3, and no QRS signs of an anteroseptal myocardial injury or infarct were detected. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

12.14 ST & T abnormality, consider anterior ischemia or left ventricular strain

ST depressed by 0.05 to 0.09 mV with T biphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, biphasic or negative in other precordial lead combinations than those typical for anteroseptal and anterolateral ischemia or left ventricular strain. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 (T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 (T inverted, that is QRS mainly positive in same lead)

(ABNORMAL ECG)

12.15 ST & T abnormality, consider anterolateral ischemia or left ventricular strain

ST depressed by ≥ 0.05 mV ith T biphasic or negative, or ST depressed by 0.10 to 0.24 mV with T flat, biphasic or negative in at least two of leads V4, V5 and V6, and no QRS signs of an anterolateral myocardial injury or infarct were detected. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

Art. no.: 2.511035 rev.: a

12.16 ST & T abnormality, consider lateral ischemia or left ventricular strain

ST depressed by ≥ 0.05 mV with T flat, biphasic or negative in at least one of leads I, aVL, V4 and V5 and no QRS signs of a lateral myocardial injury or infarct were detected. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

12.17 ST & T abnormality, consider high lateral ischemia or left ventricular strain

ST depressed by ≥ 0.05 mV with T flat, biphasic or negative in at least one of leads I or aVL and no QRS signs of a high lateral myocardial injury or infarct were detected. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

12.18 ST & T abnormality, consider inferior ischemia or left ventricular strain

ST depressed by ≥ 0.05 mV with T flat, biphasic or negative in leads II or aVF, and no QRS signs of an inferior myocardial injury or infarct were detected. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

12.19 ST & T abnormality, consider inferior lateral ischemia or left ventricular strain

ST depressed by ≥ 0.05 mV with T flat, biphasic or negative in leads II or aVF and in V6, and no QRS signs of an inferior myocardial injury or infarct were detected. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

12.20 ST & T abnormality, consider recent .... myocardial or pericardial damage

ST elevated at least 0.20 mV in at least two V leads or 0.1 mV in two inferior leads (II, aVF, III) and followed by a flat or negative T wave, and no QRS signs of a myocardial damage or infarct were detected within the same localisation. ST > 0.5T. Also:

- ST≤ -0.1 mV and -0.05 mV ≤ T < Tmin (=T flat) or
- ST≤ -0.1 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead or
- ST≤ -0.05 mV and T' or T < -0.05 with T inverted, that is QRS mainly positive in same lead

(ABNORMAL ECG)

12.21 Nonspecific ST-T abnormality (elevation)

At least two of the following criteria are met: an ST elevation of at least 0.2 mV is detected in one of the leads or depending on the main electrical direction of a T wave, an amplitude is higher than the upper limit as given on page 35, or an amplitude is smaller than the lower limit as given on page 35 .

(OTHERWISE NORMAL ECG)

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12.22 T abnormality in anteroseptal leads

T or T' <0.05 mV with T biphasic or negative in at least one of leads V2 and V3, and no QRS signs of an anteroseptal myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.23 T abnormality in anterior leads

T biphasic or negative in other precordial lead combinations than those typical for anteroseptal and anterolateral myocardial injuries was detected.

(ABNORMAL ECG)

12.24 T abnormality in anterolateral leads

T biphasic or negative in at least two of leads V4, V5 and V6, and no QRS signs of an anterolateral myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.25 T abnormality in lateral leads

T biphasic or negative in at least one of leads I, aVL and V6, and no QRS signs of a lateral myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.26 T abnormality in high lateral leads

T biphasic or negative in leads I and aVL, and no QRS signs of a lateral myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.27 T abnormality in inferior leads

T biphasic or negative in lead II or aVF, and no QRS signs of an inferior myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.28 T abnormality in inferior lateral leads

T biphasic or negative in lead II or aVF and V6, and no QRS signs of a myocardial injury or infarct were detected.

(ABNORMAL ECG)

12.29 Nonspecific T abnormality

T flat. -0.05 mV < T < T minimum and T changes other than those mentioned above were not detected.

(BORDERLINE ECG)

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12.30 T-wave table (amplitudes in mV)

		aVL	I	-aVR	II	aVF	III
Normal	upper limit	0.22	0.35	0.34	0.43	0.31	0.22
	lower limit	-0.05	0.07	0.09	0.08	0.00	-0.12
Flat	lower limit	--	-0.04	-0.04	-0.04	-0.04	--
Negative	upper limit	-0.06	-0.05	-0.05	-0.05	-0.05	-0.13

		V1	V2	V3	V4	V5	V6
Normal	upper limit	0.39	1.01	1.07	1.04	0.78	0.49
	lower limit	-0.13	0.17	0.20	0.16	0.13	0.08
Flat	lower limit	--	-0.04	-0.04	-0.04	-0.04	-0.04
Negative	upper limit	-0.14	-0.05	-0.05	-0.05	-0.05	-0.05

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13 QT Interval

13.1 Prolonged QT

A QTc duration longer than or equal to 470 ms was detected and no infarction or ischemia or left ventricular strain detected.

(BORDERLINE ECG)

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14 Hypertrophy Statements

14.1 Left ventricular hypertrophy

Note that no LVH interpretation in the case of LBBB, RBBB, nonspecific block and pre-excitation.

For the detection of a left ventricular hypertrophy, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria (modified Romhilt-Estes **point score):**

QRS amplitudes: 3 points if

- the sum of the R-amplitude in lead V5 and the absolute value of the S-amplitude in lead V1 exceeds an age and sex-dependent limit (Sokolow-Lyon). For every 0.5 mV above the limit, a further point is attributed.
- the greatest R or S deflection in the extremity leads was equal to or greater than an age and sex-dependent limit (for every 0.3 mV above the limit, a further point is attributed.)
- the greatest S deflection in leads V1 to V2 was equal to or greater than an age and sex-dependent limit (for every 0.5 mV above the limit, a further point is attributed).
- the greatest R deflection in leads V5 to V6 was equal to or greater than an age and sex-dependent limit (for every 0.5 mV above the limit, a further point is attributed).

From the first *two criteria, the one with the most points is chosen, then from this one and the* last *two criteria the one with the most points is chosen.*

ST & T: 3 points if an ST depression or a negative or biphasic wave were detected in leads I, aVL, aVF, V5 or V6. Only 1 point is attributed when the patient is under digitalis medication.

LAA: 3 points if left atrial abnormality is present and the amplitude criteria scored at least 3 points.

Electrical axis: 2 points if QRS axis ranged from -15 to -120 degrees.

Other QRS criteria: 1 point each if

- the interval between the onset of QRS and the maximum QRS vector was longer than 55 ms.
- the total duration of QRS was longer than 100 ms and no pathological Q wave detected.
- atrial fibrillation with rapid ventricular response.

14.2 Moderate amplitude criteria for left ventricular hypertrophy

The patient is at least 18 years old, and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied, but only with 3 to 5 points.

(BORDERLINE ECG)

14.3 Amplitude criteria for left ventricular hypertrophy

The patient is at least 18 years old and of all criteria for left ventricular hypertrophy, only the amplitude criteria were satisfied, and with at least 6 points.

(POSSIBLY ABNORMAL ECG)

14.4 Consider left ventricular hypertrophy

The patient is at least 18 years old and the ECG scored at least 5 points according to the criteria above (3 of these points must stem from the amplitude criteria). If more that 3 points are calculated from the amplitude criteria, only three are considered i.e. only three amplitude criteria points go towards the total points score.

(POSSIBLY ABNORMAL ECG)

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14.5 Left ventricular hypertrophy

The patient is at least 18 years old and the ECG scored 6 points according to the criteria above (3 of these points must stem from the amplitude criteria) and scored 0 points for ST. If more that 3 points are calculated from the amplitude criteria, only three are considered i.e. only three amplitude criteria points go towards the total points score.

`with repolarisation abnormality` is added to the above statement if points have been obtained from ST-T.

(ABNORMAL ECG)

14.6 Right ventricular hypertrophy

Note that no RVH interpretation is given in the case of RBBB, LBBB, nonspecific block and pre-excitation.

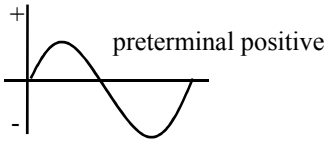
For the detection of a right ventricular hypertrophy, points are allocated to different ECG characteristics possibly caused by this condition according to the following criteria:

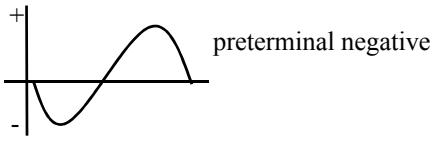
Amplitudes: 3 points if

- the R deflection in lead V1 was greater than an age- and sex-dependent limit
- the S deflection in the same lead was not deeper than an age and sex-dependent limit (these limits are different in the case of an incomplete RBBB)
- an S wave deeper than an age and sex-dependent limit was detected in lead V5 or V6, and the R/S ratio was less than an age and sex-dependent limit in these leads.

ST & T: 3 points if

- an ST depression and a negative or biphasic T wave were detected in leads V1 or V2. Only 1 point is attributed when the patient is under digitalis medication.
- ST slope < -0.45 mV/s
- T negative, ST < -0.05 mV, T biphasic, preterminal negative (see illustration).





Electrical axis: 2 points if

- The QRS axis ranged from +110 to +180 degrees, or from -120 to -180 degrees.

1 point if

- The QRS axis ranged from +90 to +110 degrees

QRS duration: 1 point if

- the total duration of QRS ranged between 100 ms and 120 ms (100 ms < QRS duration ≤120 ms)
- occurrence of intrisicoid deflection V1 > 0.04s after QRS onset

14.7 Consider right ventricular hypertrophy

The ECG scored 4 points according to the above criteria or 3 points in the presence of a right atrial hypertrophy or of a sagittal electrical axis (i.e. S1, S2, S3 pattern).

(POSSIBLY ABNORMAL ECG)

14.8 Right ventricular hypertrophy

The ECG scored at least 5 points according to the above criteria. “with repolarisation abnormality” is added to the above statement if points have been obtained from STT.

(ABNORMAL ECG)

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15 Miscellaneous Statements

15.1 S1, S2, S3 pattern

An S-wave of at least 0.2 mV was detected in at least two of leads I, II and III, and the R/S quotient did not exceed 0.25 in the same leads.

(OTHERWISE NORMAL ECG)

15.2 WPW pattern, type A

Delta waves are detected in at least 3 leads. The QRS sum was positive in lead V1. PR interval must be <160 ms. If P axis <0°or > 90° then delta waves must be detected in 5 leads; if PR time > lower limit then delta waves must be detected in 5 leads.

(ABNORMAL ECG)

15.3 Consider WPW, type B

Delta waves are detected in at least 3 leads. The QRS area was negative in lead V1. PR interval must be <150 ms. If P axis <0°or > 90° then delta waves must be detected in 5 leads; if PR time > lower limit then delta waves must be detected in 5 leads.

(ABNORMAL ECG)

15.4 R-S transition zone in V leads displaced to the right

No pathological Q wave in V1 - V6. An R/S quotient of at least 3 was detected in lead V2, and the duration of QRS was not longer than 120 ms.

(OTHERWISE NORMAL ECG)

15.5 R-S transition zone in V leads displaced to the left

No pathological Q wave in V1 - V6. An R/S quotient less than 0.75 was detected in lead V5, and the duration of QRS was not longer than 120 ms.

(OTHERWISE NORMAL ECG)

15.6 *Possible reversal of the arm leads

The QRS complexes in leads I and V6 were more discordant than concordant, and the P-wave in lead I was < 0.04 mV. (P(I) < 0.04 mV; QRS axis < -100° or > 120°

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16 Low Sensitivity Statements

When 'LOW' sensitivity is selected, the following statements regarding nonspecific ECG findings are suppressed:

- Indeterminate axis
- Nonspecific intraventricular delay
- Nonspecific ST abnormality (depression)
- Nonspecific T abnormality
- Nonspecific ST-T abnormality (elevation)
- Cannot rule out myocardial damage
- Moderate amplitude criteria for LVH

If one of the above statements has been suppressed, and no other abnormalities are found, the normal/abnormal classification will be replaced by "No specific ECG abnormalities".

The statement "Atrial fibrillation/flutter" is replaced with "Irregular rhythm, no P-wave found".

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17 Paediatric Interpretation

As ECG characteristics of a human being change during childhood and adolescence, age-based parameters have to be applied for the interpretation of a paediatric ECG in order to better assess its variations.

The ECG interpretation program on the SCHILLER ECG devices for pediatric was developed in cooperation with leading cardiologists of university hospitals and is intended for use on ECGs of pediatric from birth up to the age of 18.

The ECG interpretation program for pediatric differentiates between the following age categories:

- the first 24 hours in life of a newborn child
- 1-2 days
- 3-6 days
- 7-30 days
- 1-2 months
- 3-5 months
- 6-11 months
- 1-2 years
- 3-4 years
- 5-7 years
- 8-11 years
- 12-17 years

Following is a description of the main differences between the interpretive statements given in the paediatric ECG program, and the adult interpretation program.

17.1 Rhythm analysis

For rhythm analysis no distinction other than applying age-dependent limits is made between pediatric and adults.

17.2 WPW syndrom

Age-dependent limits are applied. The 12 standard leads are searched for delta waves. The presence of delta waves in at least 3 leads and a duration of PR interval of less than 150ms (WPW pattern type A) or of less than 140 ms (WPW pattern type B) will satisfy the criteria for Wolff-Parkinson-White syndrome. When the frontal P axis is below 0° or above 90°, delta waves must be present in at least 5 leads and the duration of the PR interval must be less than the average, age-dependent duration. When the R/S ratio in lead V1 is less than 1, the statement **WPW pattern type B** is produced, otherwise the statement **WPW pattern type A** will be given.

17.3 Analysis of ST segment and T wave

For pediatric up to the age of 12, the leads V1 to V4 are not used for ST &T analysis and no attempt will be made to interpret signs of myocardial infarction. Contour abnormalities are interpreted as in the adult ECG.

17.4 Dextrocardia

For the diagnosis of **dextrocardia**, the sum of the R and |S| amplitudes in lead V1 must exceed the sum of the R and |S| amplitudes in leads V5 and V6 by at least 90 % each, no criteria for intraventricular block should be satisfied and at least two of the leads I, aVL, V5 and V6 should either have a Q amplitude > 1/4 the sum of the R and |S| amplitudes and an R amplitude > 100 µV OR should show an RSR' pattern with an R amplitude < 50 µV , an R' amplitude > 100 µV and a S amplitude > 1/4 the sum of the R and |S| amplitudes.)

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17.5 Interpretation of P wave

Interpretive statements for atrial activity, such as prolonged P-R interval, bi-atrial abnormality, right atrial abnormality, left atrial abnormality, possible left or right atrial abnormality, are made.

The statement **prolonged P-R interval** is produced for a PR duration longer than the P limit for the patient's age (The P limit is defined as the 98 % percentile (for the patient's age) + 20 ms).

The criteria for **possible left atrial abnormality** is satisfied, when PTF (= P terminal force, resulting from the largest amplitude of the terminal negative portion of the P wave in lead V1 and its duration) is < -6 mVms .

An interpretative statement is made for **left atrial abnormality** when the amplitude of the negative portion of P in lead V1 is < -200 µV or when the duration of the P wave is longer than 140 ms and the amplitude of the negative portion of P in lead V1 is <-100 µV.

An interpretative statement is made for **right atrial abnormality** when a P maximum > 250 µV is present in at least one lead.

The criteria for **bi-atrial abnormality** is satisfied in the presence of both left and right atrial abnormality.

17.6 Determination of electrical axis

The determination of the electrical axis is carried out the same way as for an adult , however, the statement **'axis normal considering age'** or **'axis abnormal considering age'** depends upon the limit values for age.

17.7 ECG voltages

An interpretative statement is made for **low voltage** when the peak-to-peak QRS amplitudes do not exceed 500 µV in any frontal leads. When the peak-to-peak QRS amplitudes in the frontal leads range between 500 µV and 1000 µV (exclusive) and the peak-to-peak QRS amplitudes in the chest leads being below 1500 µV, then the criteria for **low voltage** are satisfied, too.

17.8 Intraventricular conduction delay

In general, no search is made for intraventricular conduction delay in the presence of 'WPW'.

Left bundle branch block

1. The QRS duration is longer than the limit for age. The R/S ratio in leads V1 and V2 is less than or equal to 1. If S (in lead V6) is smaller than the average value for age , then S (in lead I) should be ≥ -0.2 mV.
2. The R/S ratio in lead V6 must correspond to the limit value for age, the same applies to the R/S ratio in lead I. Q in lead I must be ≥ -0.05 mV, and in lead V6 ≥ -0.03 mV. The mean spatial velocity of the ECG within the mid-third section of QRS must be less than the limit value (58,5 mVs).

When any of the conditions mentioned under item 2 is not fulfilled, either the interpretative statement '**nonspecific intraventricular block**' (when exceeding the limit values for blocks) or '**nonspecific intraventricular delay** ' (when exceeding the limit values for conduction delay) is made. Otherwise the statement '**left bundle branch block**' or '**incomplete left bundle branch block**' is given, wherever appropriate. QRS duration must be fullfilled in any case.

Right bundle branch block

The criteria for RBBB is satisfied in the absence of LBBB or in the presence of a QRS complex with M or W-shaped curves in leads V1 or V2.

When these conditions are fulfilled, either the interpretative statement '**right bundle branch block** ' (when exceeding the limit values for blocks) or '**incomplete right bundle branch block** ' (when exceeding the limit values for conduction delay) is made.

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Left fascicular blocks

Criteria for the presence of left anterior fascicular block : QRS duration < limit value for age (QRS duration ≥ limit value only in the presence of RBBB); -30° ≥ QRS axis > -120°; no Q in lead aVF; R/S ratio in lead aVF ≤ 0.6; S in lead V6 ≤ limit value for large S amplitude in lead V6.

Criteria for the presence of left posterior fascicular block: QRS duration < limit value for blocks for the patient's age (QRS duration ≥ limit value only in the presence of RBBB); 115° ≤ QRS axis ≤ 180°; R or R' in lead II ≥ 0.8 mV; R or R' in lead III ≥ 1.0mV; Q ≤ -0.02 mV in leads II,III,aVF; Q duration in leads III,aVF ≤ 40 ms.

17.9 Prolonged QT

When the limit value for age is exceeded, an interpretative statement is made for **prolonged QT** under the condition that there are no signs of intraventricular delay (including block), ischemia or left ventricular strain.

17.10 Ventricular hypertrophy

Left ventricular hypertrophy

No LVH interpretation in the presence of blocks or WPW syndrome.

The statement '**Consider left ventricular hypertrophy**' is made when either |S V1| > limit , |S V1| > 0.25* peak-to-valley value of QRS or R in lead V6 > limit value -0.2 mV.

'**Left ventricular hypertrophy**' is considered when the conditions for 'consider left ventricular hypertrophy ' are fulfilled and, |S V1| > limit value of +0.5 mV and R in V6 > limit value +0.5 mV or when (R V6 +|S V1|) > limit.

'**Left ventricular hypertrophy with repolarisation abnormality**' is considered when the conditions for left ventricular hypertrophy are fulfilled and when in any of the leads I,aVL,V4,V5,V6 following criteria are met: ST amplitude < J amplitude, ST amplitude < -0.05 mV, and R amplitude ≥ 1.1 mV.

The statement '**Left ventricular hypertrophy with strain**' is produced when the conditions for left ventricular hypertrophy with repolarisation abnormality are fulfilled and when in any of the leads I,aVL,V4,V5,V6 at least two show the following characteristics: max (R,R') > |min (Q,S,S')| and T amplitude < ST amplitude and < -0.2 mV .

Right ventricular hypertrophy

No RVH interpretation in the presence of LBBB, RBBB, nonspecific block or WPW syndrome.

In the presence of an incomplete right bundle branch block no detection is made for right ventricular hypertrophy when max (R,R') is ≤ 1.5 mV (1 mV for pediatric younger than 1 year).

The statement '**Consider right ventricular hypertrophy**' is produced when any of the following conditions is fulfilled:

- min (S,S') < S limit value of -0.2 mV and |min (S,S')| > 0.25* (max (R,R') - min (Q,S,S') in lead V6, or
- S or S' in V6 is not equal to 0 and R/S ratio in V6 < limit, or
- S or S' in V1 is not equal to 0 and R/S ratio in V1 > limit, or
- Q in V1 < -0.02 mV and R in V1 > 0.5 mV, or
- the child is older than 1 year and younger than 8 years and T in V1 > 0.1 mV and T' in V1 = 0, and a negative or biphasic T wave has been detected in leads V5 and V6.

'Right ventricular hypertrophy' is suggested when max (R V1, R' V1) > limit value, or when Q in V1 < -0.02 mV and max (R V1, R' V1) > 0.75 mV .

The statement **'right ventricular hypertrophy with repolarisation abnormality'** is produced when the criteria for right ventricular hypertrophy have been met and when ST amplitude < J amplitude in the leads V1,V2,V3 or when ST or T amplitude in the same leads ≤ -0.1 mV and when ST or T amplitude in the leads V4,V5,V6 exceeds or equals to -0.1 mV not more than once.

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The statement **'Right ventricular hypertrophy with strain'** is produced when in at least two of leads V1,V2 and V3 an ST depression with inverted T wave of less than -0.2 mV in amplitude has been detected.

The limit values and criteria for the paediatric ECG interpretation statements are based upon following publications:

- Davignon A et al. , Normal ECG standards for infants and children, Pediatr. Cardiol. 1979/80; 1:133-152.
- Liebman J, Plonsey R, Gilette PC, eds. Paediatric Cardiology. Williams and Wilkins, Baltimore 1982.
- Macfarlane PW, Veitch Lawrie TD,Comprehensive Electrocardiology, Pergamon Press, New York 1989
- Liebman J, Plonsey R, Rudy Y, Paediatric and Fundamental Electrocardiography, Martinus Nijhoff Publishing, Boston 1987
- Gutheil H, Kinder-EKG, Thieme, Stuttgart 1989

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18 Thrombolysis Interpretation

The SCHILLER Thrombolysis Software (SCHILLER STP) is a software program designed to aid the physician's decision-making process in the pre-hospital and emergency department setting by using medication, patient age, gender and ECG features to provide the predicted probability of acute cardiac ischemia or acute coronary syndrome (ACS). The SCHILLER STP software package enhances the computer-assisted ECG analysis capabilities as a software option in some SCHILLER ECG recording devices.

The information used to calculate the predicted probability of acute cardiac ischemia is available for real-time in the emergency department and as retrospective review to aid quality assurance.

Clinical studies at the Thorax Center of the Erasmus University in Rotterdam (Prof. Simoons), have proven the benefits of this tool.

It is possible to manually select or configure the ECG device to automatically report the probability of acute cardiac ischemia on the printed ECGs. To prompt the report generation, one must only enter three variables in the patient ID field: age, gender and medication. The reports can be stored in SCHILLER's SEMA Data Management System.

The SCHILLER STP provides an additional tool to assist with the diagnosis of acute cardiac ischemia, also including unstable angina pectoris and acute myocardial infarction.

In order to calculate the predicted probability of acute cardiac ischemia, it is necessary to examine three ECG features from the computerized ECG analysis:

- presence or absence of abnormal Q waves
- presence and degree of ST segment elevation or depression
- presence and degree of T-wave elevation or inversion.

In order to allow conclusive results, it is necessary that the ECG features appear in minimum two related leads and causes that might interfere with the ECG interpretation such as secondary LVH, RBBB and LBBB repolarization abnormalities, artificial pacemaker or early repolarization can be excluded. Although the appearance of any single ECG feature is not conclusive for a diagnosis, the accumulation of the most important ECG features are excellent indications for the detection of acute coronary syndrome.

The SCHILLER STP report is used in addition to the standard automatic ECG report in clinical settings where acute cardiac ischemia is a major diagnostic concern.

The SCHILLER STP report is based on the standard ECG report, showing a standard ECG trace with ten seconds of ECG waveforms and standard waveform measurements. It also includes any number of the following interpretive statements indicating the prediction of thrombolysis:

- ST-T elevation, acute anterior infarct
- ST-T elevation, acute inferior infarct
- possible infarct or other abnormality
- no significant abnormalities
- ECG consistent with large infarction
- ECG consistent with medium-sized infarction
- consider thrombolytic therapy if symptoms are suspect for infarct and patient is 70 years or less
- consider thrombolytic therapy if symptoms are suspect for infarct and patient is 80 years or less

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