Checklist Ergonomic Requirements Dental Units, for *Industrial use*

A checklist for assessing ergonomic qualities of units (for prototype or already on market)
Based on the "Ergonomic Requirements for Dental Equipment".

Unit	
Working stool dentist	
Date assessment	
Revision	
Reviewer(s)	

1. Working stool dentist.		**Notes**
1. The working stool has disposal of a seat with a horizontal part at the rear with a minimum length of 15 cm and an oblique front part declining 20°, without going up of the sides of the seat.		
2. A slight inclination forward of the seat of maximally 6-8° can be used.		
3. The maximum depth of the seat shall be 40 cm and the width 40 cm, maximally 43 cm.		
4. The minimum sitting height of the (impressed) seat is 47 cm and the maximum height 63 cm (or higher for taller dentists).		
5. A backrest with lumbar/pelvic support of 10-12 cm high supports the top of the backside of the pelvis, adjustable vertically from 17-24 cm and also horizontally.		
6. There should be no contact between back rest and the back musculature on either side of the lumbar/pelvic support of 10-12 cm against the top of the pelvis. For leaning backward the backrest may continue upward and also a little backward.		
7. The backrest with pelvic support should not exceed a width of 30 cm.		
8. The backrest is elastic over a short distance of 1-2 cm, can rotate around a horizontal axis with an angle of 25° upwards and downwards while the upholstery should be flexible enough for adaptation to the individual curvature of the back.		
9. The upholstery of the seat has to be sufficiently hard with a roughened surface.		
10. If armrests are desirable, 2 armrests are needed, continuously adjustable.		

2. Patient chair. General requirements.		
1. The patient chair has a flat surface to position patients, with differences of length of about 50-60 cm, without feeling pressure of the chair against their body.		
2. The angle between seat and support for lower legs is restricted to a smooth transition of not more than 15° for the necessary horizontal position of the patient, to avoid damming up of the blood circulation in the head of the patient.		
3. A smooth transition without a height difference between upholstery of back and seat is necessary for a lying patient, as the lower part of the back of the patient lies as well on seat and backrest of the patient chair.		
4. Just before the rear of the seat a sunken area, with only a small deepening of the seat by 3 cm for the buttocks of the patient, has to be present.		
5. The lower legs have to be positioned in an about strait line with the body.		
6. The patient should lie with the shoulders completely supported.		
7. The lower part of the neck (C4-C7) has to be supported in direct contact with the support of the shoulders. The support of the lower neck has to match the individual height of the neck curvature varying normally from about 4 until 8 cm.		
8. Positioning upper body and head of the patient in a proper relation with the backrest together with the headrest should be attained by shortening and lengthening the back.		
9. Upper part of the neck (C1-C3) has to be left free for movements of neck and head.		
10. The patient must be able to lie in a straight line on seat and back of the chair in the 11.00, 12.00 and 13.00 o'clock positions (so parallel with the longitudinal axis of the patient chair and diagonally to the right and the left).		

11. The 3 movements of the head of the patients to orient the working field in the mouth towards the viewing direction of the dentist are: * *forward* to a horizontal position of the occlusal plane of the lower jaw and *backward* until a position of the occlusal plane of the upper jaw 20-25° backward; * *obliquely sideward*, about 30° to the right or the left; * *rotation of the head*, maximally about 45°, to the right and to the left.		
12. The upholstery must be firm but not hard and allow a certain adaptation to the anatomical shape of the patient.		
13. The width of the back of the patient chair has to be as small as possible for a standing dentist in order to work in a correct posture.		
14. Armrests have to be minimal in the form of foldaway armrests which can be put aside when the dentist is working standing, so that he is able to reach the mouth of the patient without bending forward and stretching out arms.		
15. A sitting dentist needs a free space for his feet and foot control so that he is able to sit unhampered with his legs in a correct posture.		
16. For the patient's comfort an individually adjustable lordosis support could be an acceptable solution for supporting the individual curvature of the back.		
17. The upper body of the patient rotates, when moving downward or upward, around an axis below the underside of the pelvis at about 13 cm from the rear of the seat. This needs to be considered when designing the mechanism for the movement of the back.		

3. Dimensions patient chair, except the head and neck support.		
1. The minimum height of the seat is 35 cm and the maximum height is 90 cm. *The measurements are done below the lowest point of the horizontally lying patient, below the buttocks, about 13 cm from the rear of the seat. This place correspondents with the underside of the back of the patient = the underside of the pelvis (see also 3.14).*		

Items 2 through 7 are in relation with the principle, described in the Ergonomic requirements for dental equipment, regarding shortening and lengthening of back and headrest together in relation with the length of the patient. 2. The minimal length of the back for supporting the shoulders of a small patient is 41 cm on the sides of the top of the back; and in the middle of the top of the back 44 cm, because the shoulder line goes up a little. So that the height of shoulders in the middle, until the lower part of the neck, is a few cm higher.		
3. The maximum length of the back for supporting the shoulders of a tall patient is 56 cm on the sides of the top of the back; and in the middle of the top of the back 59 cm.		
4. The length of the headrest above the shoulder line in the middle is 25 cm.		
5. Length of back and headrest together is minimally 69 and maximally 84 cm.		
6. The resulting range for adjusting the length of back together with headrest is 15 cm. This should be attained by shortening and lengthening the back.		
7. Width of the back at the top of the side of the back, supporting the shoulders, is 42 cm.		
8. The elbows of the patient can be supported on foldaway elbow rests. Both supports can be 11 cm broad, supporting the elbows at some distance from the upper body.		
9. The width of the part of the back where the elbows need support - by fold away elbow rests - is 48 cm, because the dentist must be able to treat a sitting patient in standing position, without bending forward en stretching out arms.		
10. For the elbow of a small patient the support must be available 34 cm below the top of the back and for a tall patient 49 cm below the top, starting from shortening and lengthening of the back with headrest. The support must therefore be more than 15 cm long in order to enclose the elbows.		
11. The underside of the back can narrow to 43 cm, the width of the seat to make a standing position easier for a dentist.		

12. The total thickness of the backrest has to be very small: 4 cm; and in the middle part not more than 6 cm over a distance of about 50 from the top of the headrest, for the smallest to treat patient..		
13. The width of the seat is 43 cm but where the support for the lower legs starts, this widens so that at the end of the leg support it becomes 55 cm for spreading legs and placing patients with the body diagonally.		
14. The deepening of the sunken area in the seat is approximately 3 cm, about 13 cm from the rear of the seat. The width of the deepening is about 15 cm.		
15. The total length of seat and support for lower legs has to be 122 cm, with a length of the seat of 58 cm and a length of the support for the lower legs of 64 cm.		
This item belongs to the in the Ergonomic requirements described solution. 16. For the vertical sitting position of the patient, the back should be placed vertically, the seat horizontally and when movable the leg support at an angle of 60° (in relation with a vertical plane).		
17. For sitting down and getting off the back should be positioned with an angle of 70-80° backward (in relation with an horizontal plane), with the seat declining 10° backward and the leg support at an angle of 60°.		
18. The height of the seat for a seating patient is not a fixed height. This varies according to the wishes of the dentist and could be 50 cm.		
19. The movement of the patient from being seated upright to achieving a horizontal position has to take between 10 and 20 seconds. The movement in the reverse direction takes just as much time		
20. A sitting dentist needs a free space of 81cm for his feet and foot control behind the basis of the chair, between basis of the chair (when existing) and top of the headrest, of a horizontally placed back and headrest for treating a small patient (with a length of 1.56 m). The length of backrest and headrest together is then 69 cm. The required free way space at this has to be 81 cm between rear side of the headrest and basis of the chair.		
21. Also enough space is needed for the feet of a standing dentist. This can presumably be achieved by rounding off the basis, for the width of an obliquely placed foot of 13 cm.		

22. In connection with the free space for feet and foot control it is impossible to obtain an acceptable solution for a separate foot control attached to the basis of the patient chair for controlling movements of the patient chair. As the distance for a balanced operating of this foot control is too far.		

4. Support of head and neck by headrest and neck support.		
The items 1,2 and 5 are in relation with the principles described in Ergonomic requirements for the functioning of head and neck rest. 1. The width of the headrest above the shoulder line is on the sides of the neck 24 cm and declines then upward until 20 cm where the backside of the head is positioned, about 17 cm above the shoulder line. Above this contact area (with the back of the head) the width of the headrest can decline and follow the rounding of the head of the patient. The width can be 16 cm when the headrest can be turned sufficiently sideward.		
2. The thickness of the headrest should be about 3 cm, towards the top dropping to 0.5 cm to attain as much space as possible for an easy vertical reach to patient's mouth. Particular smaller dentists do not have enough space between upper legs and lower arms for a thicker head rest and will be forced then to elevate arms and shoulders and to spread the arms too.		
3. For a good support of the upwards going curvature of the neck a small support of 5-6 cm below the lower part of the neck, in connection with support of the shoulders, is needed. This has to match the individual height of the neck (normally 4-8 cm). The upper part of the neck remains unsupported.		
4. The headrest should be able to be turned backward 20° and forward 15°.		

5. Foot control dental unit.		
1. A foot control can be designed with a pedal on which the foot is placed either entirely or partly. Placing the whole foot on the pedal causes an unfavourable load. Therefore it is necessary to place the heel on the floor for supporting the foot, while the front part is placed on the pedal. The foot should be raised from the heel by an angle of between 5 an 15°.		

2. The length of the foot control has to be as short as possible in relation with the needed free way space for foot of the dentist and foot control (see 3.12).		
3. The length of a pedal could be maximally 22 cm for a tall dentist, taking into account the fact that about 15 cm of the back of the shoe is not placed on the pedal. In practice a shorter length would be preferred.		
4. The width of the pedal should be 12.7 cm. In practice a smaller pedal will be sufficient, so 7 cm may be used.		
5. A foot control can also be designed with a pedal operated by pressing on the side by movements to the right or the left.		
6. Preference has to be given to this mode of operation of the pedal, since the heel rests completely on the floor and only small movements of maximally 15° are needed.		
7. A combination also exists where the pedal is placed in a certain position in relation to the desired speed and then the foot is placed on the pedal for operation. This is slightly more complicated.		
8. The support for moving the foot control with the foot should be 8 cm high (no higher) and 13 cm broad. A half open support works differently for the right and left foot and is therefore less advisable.		
9. The weight of the foot control should be designed so that the foot control can easily be repositioned, without it sliding away. In the case of a light foot control, non slip material can be attached to it.		
10. The foot control should be designed as simply as possible, there should be no more functions than necessary and it should be simple to operate.		

7. Dental operating light.		
1. A dental operating light must be able to be positioned around the head of the dentists, before and sideward, in all working positions, so that the light beam is running parallel to the viewing direction, with a maximal deviation of approximately 15°.		
2. A dental operating light needs 3 orthogonal axes.		
3. By the third axis the operating light can be positioned obliquely with an angle of minimally about 45 ° for placing it in a manageable position on the side of the head of the dentist for a shadow free lighting in the mouth of the patient.		

4. The adjustment of the operating light around 3 axes has to be made in such a way that it can easily be carried out with a balanced movement, preferably with one handle. This can be reached by using 3 orthogonal axes.		
5. The maximal height of the operating light for a tall sitting dentist is 177 cm and the minimum height for a small sitting dentist is 140 cm.		
6. The maximum reach for the operating light behind the headrest, starting from the SRP (transition seat and back patient chair) and going to the back is 125 cm, for the range of mentioned heights in 7.5.		
7. The maximum height of the operating light for a standing tall dentist is 214 cm.		
8. The reach of the operating light for a dentist standing before the patient is 95 cm before the SRP.		
9. The illumination should be continuously adjustable from 8000-25.000 lx.		
10. The range of the colour temperature should lie around 5500 Kelvin.		
11. The colour rendering index (CRI) should be minimally 85 Kelvin, but if the operating light can be used for colour matching it must be more than 90.		
12. If the operating light can be used for colour matching on the basis of a correct colour temperature and CRI, this colour temperature has to be available also with the lower illumination level needed for colour matching. (As not any glitter has to be observable while a clear impression has to be possible of differences regarding structure and colours of the surface of the tooth/teeth).		
13. Dimensions of the illumination rectangle at a focal distance of 70 cm are:		

8. Using matt surfaces.		
1. The surfaces of dental equipment and instruments have to be matt, to avoid fatiguing glittering effects on the eyes of the dentists		
2. The colours used for dental equipment should be light for an optimal contrast.		

9. Positioning instruments with tubing (dynamic instruments).		
Item 1 and 2 have to be answered combined because they belong together. 1. Dynamic instruments should be positioned within: - the field of vision, 30° right and left of the mid-sagittal plane (dividing the upper body in 2 equal parts) of the dentist in the sitting positions around the chair. - a reach of 30-40 cm from the dentist in the sitting positions from 8.30-12.30 o'clock for right handed dentists and 11.30-15.30 o'clock for left handed dentists.		
2. The instrument console needs to have an adequate reach so that it is possible to place the tubing with attached instruments within the direction of the grasp of the dental operator, treating as well very small and very tall patients, with a maximal length of backrest and headrest together.		
3. Dynamic instruments should be positioned within an angle of between 30-60° with regard to the mouth of the patient (or as near to this as possible), treating as well very small and very tall patients. If a dental assistant uses the multifunction syringe or transfers instruments to the dentist the positioning of instruments will need adjustment.		
4. The instrument console needs to be moved, with the instruments in the desired position, with little effort and without the console slipping away, treating as well very small and very tall patients.		
5. Dynamic instruments associated with a front delivery system, here the hand piece tubing, have to be balanced in such a way that no traction is felt. Length (about 80 cm) and height of the tubing have to match the desired reach of the instruments when these are being used. Instead of bolting the hand piece tubing, attachment has to be done in such a way that no traction or other disturbing forces are felt. Interference of tubing with operating light, microscope should not be possible.		
6. Dynamic instruments should hang down with an angle of 45° in relation to a vertical plane; and al least 6 cm but preferably 10 cm should be free hanging in relation with the instrument console.		

7. The vertical distance of the head of the instrument below the instrument console is approximately 7cm, close above the working height in the mouth of a horizontally placed patient.		
8. For a seated dentist the dynamic instruments have to be positioned as close as possible by the working area. This is about 5 cm above the working height in the mouth, being minimally 78 + 5 cm = 83 cm for a small dentist and maximally 107 + 5 cm = 112 cm for a tall dentist.		
9. The working height for a standing tall dentist is 144 cm to be able to pick up and replace instruments without forward bending with upper body and head.		
10. The distance between dynamic instruments should be minimally, about 6 cm, measured from the middle of the instruments and they should be positioned in such a way that damage caused by sharp instruments can be avoided.		
11. Too broad a range of instruments should be avoided. An instrument console with a width of about 40 cm appears to be a good solution. With an increasing number of instruments the distance of the instruments have to become 5 cm, placed, hanging down with an angle of 45° (see 9.6).		
12. The underside of the instrument console should be flat (or rising at the backside) so that this can be positioned about 10 cm above the breast of the patient.		
13. The control panel for operating different functions, e.g. the patient chair, can be best positioned at the side of the instrument console, but nearby the working height so that far and high reaching of arms, together with lifting of the shoulders, can be avoided.		

10. Positioning hand instruments for the dentist.		
1. It should be possible to position the tray for hand instruments at a distance of 20-25 cm of the body of the dentists at a minimum working height of 78 cm for a small sitting dentist and a maximum working height of 107 cm for a tall sitting dentist.		
2. The vertical distance from the flat underside (see 9.12) of the instrument console to the tray has to be about 10 cm, around 4-5 cm below the dynamic instruments.		

3. The tray is fixed in the centre below the instrument console with a horizontal arm just below the underside of the instrument console to avoid contact with the breast of the patient. This arm is bent at the end, nearby the swiveling arm/holder – itself of about 5 cm – for the tray holder attached to this by a mechanism which allows the position of the tray to vary horizontally. The first arm, fixed below the instrument console, can reach up to 10 cm sideward of the console at both sides, for use of the tray at both sides of the console. Any further handle designed to aid the positioning of the console must not interfere with the placing of the tray and/or its holder.		

11. Positioning instruments for the dental assistant.		
1. The instruments for suction and, where needed, other instruments with tubing used by the dental assistant, must be positioned as far as possible toward the front of the upper body of the dental assistant, when positioned between spittoon and dental assistant. At a minimum working height of 78 cm and a maximum working height of 116 cm for use in a sitting and standing position. An oblique position of the instruments, about 45°, is desired or when possible, the instruments should hang down to allow a natural way of grasping.		
2. When these instruments are also used by the dentists the reach must fulfill the requirement of being at a distance of 30-40 cm in the different working positions of the dentists, so positioned next to the head of the patient.		
3. The form for the holders of the instruments has to be ample funnel-shaped. This is also important for infection prevention.		
4. Even when the instruments for the dental assistant come from the rear the same requirements as mentioned above apply in principle.		
The best place for a tray with hand instruments for a dental assistant is still a subject of discussion. As the best solutions could be considered a tray coming from the rear that is positioned between body of assistant and head of the patient or a body tray on the breast of the patient, so that rotating and sideward bending of upper body and head of the assistant can be avoided. If the tray is not placed as described the assistant has to learn to turn with the working stool in the direction of the tray to avoid		

rotations and sideward bending.		

12. Positioning spittoon.		
1. The spittoon being placed at the side of the patient chair should be movable for obtaining space for dental assistant and suction unit when placed next to the spittoon.		
2. The diameter of the spittoon is		

13. Use equipment for right- and left handed dentists.		
1. Separate unit for left handed dentists or a unit for use by right- and left-handed dentists.		

14. Screen related with equipment.		
1. Starting from a correct sitting posture, a horizontal line is drawn from the eyes toward the topmost line of the text on the screen. This determines the range of the heights of the screen: 119-152 cm, this being the heights of the eyes of a small and a tall dentist respectively, when sitting with an angle of 110° between lower and upper legs.		
2. The mid-sagittal line of the dentist (dividing his upper body in two equal parts) corresponds with the middle vertical line of the screen.		
3. In order to provide adequate observation, good contrast is required on the screen. The relation 10 : 1 can be used; below 1 : 3 the legibility clearly decreases. The use of colour will never improve the legibility. When using colours it is necessary to optimize the contrast.		

15. Infection prevention.		
1. The quality of water within dental equipment has to be guaranteed in relation to disinfection by incorporating good design and using all measures necessary to this end. The dentist is responsible for the quality of the water supply to the unit.		
2. The system should function (semi)-automatically when the equipment is not in use.		
3. Operation of the system must be easy for both dentist and dental assistant.		
4. The dentist must be informed about how he can monitor water quality with dip slides		
5. The suction system can be cleaned and disinfected user friendly.		
6. Surfaces of equipment need to be smooth, without joints, sharp transitions or edges and easily accessible for cleaning and disinfection.		

Authors:
drs. Rolf de Ruijter r.a.g.de.ruijter@umcg.nl
prof. drs. Oene Hokwerda
Joseph Wouters

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