# Screening of donor semen samples before acceptance in a donor sperm bank

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## Disclosure

I have no commercial or other activities that may reflect on the contents of this lecture

## Lecture objectives

- Give an short overview of different society guidelines for selection criteria for sperm bank donors
- Discuss the different pre-freezing and post-thaw semen parameter criteria for sperm bank donors
- Discuss factors that may influence donor semen quality

## Selection criteria for semen donors

- General criteria
  - Society guidelines
- Semen quality criteria

## International societies guidelines

## American Society of Reproductive Medicine – 2006 Guidelines for Sperm Donations (1)

Selection criteria of Donor

- Good health status
- Absence of genetic abnormalities
- Legal age (<40 years)
  - Risk for increased rate of sperm aneuploidy
- Selection of donors with established fertility is desirable - but not required
- Psychological evaluation

ASRM, 2006

## American Society of Reproductive Medicine – 2006 Guidelines for Sperm Donations (2)

Semen testing

- Several samples to be examined
- After a 2- to 5-day abstinence
- Examined within 1 to 2 hours after ejaculation
- No uniformly accepted minimum semen standards
- In general, the minimum WHO criteria for normal semen quality can be applied (WHO, 1999)

ASRM, 2006

## British Fertility Society (BFS) Guidelines – 2008 (1)

- Age
  - Upper limit = 40 years
  - If >40 increased infertility, miscarriages and congenital malformations
- Screening for fertility
  - Semen to be assessed according to WHO (1999) criteria
  - In general well described relationship between semen parameters and conception

ABA, ACE, BAS,BFS, RCOG, 2008

## British Fertility Society (BFS) Guidelines – 2008 (2)

- Screening for fertility (continued)
  - This relationship does not seem to exist for use of thawed-cryopreserved sperm in IUI
  - BAS (1999) no recommended minimum acceptance criteria for donors based on semen quality or post-thaw survival rates

ABA, ACE, BAS,BFS, RCOG, 2008

## British Fertility Society (BAS) Guidelines – 2008 (3)

- Screening for fertility (continued)
  - Growing awareness of relationship between semen quality and sperm DNA integrity
  - Growing awareness of relationship between sperm DNA integrity and embryo quality
- Recommendation (2008)
  - Only those men with (pre-freeze) semen quality values above WHO (1999) normal values should be accepted as donors

ABA, ACE, BAS,BFS, RCOG, 2008

## ESHRE (predictive) criteria for Donor semen (1998)

- Most predictive factor
  - Number of motile spermatozoa per straw
  - Number of motile spermatozoa inseminated
  - No absolute standards from semen examinations

Barratt et al.,1998

## ESHRE (predictive) criteria for Donor semen (1998)

- Sperm functional tests
  - Hamster penetration test
  - CASA motility analysis
- Limitations
  - Number of pregnancies per donor

Barratt et al.,1998

## Selection criteria for semen donors

- Semen parameters
  - Minimum requirements for donor semen
  - Pre-freeze and post-thaw results
  - Variability in donor semen quality

## WHO 1999 and 2010 criteria for normal semen quality (ASRM, 2006; BAS,2008)

| | WHO 1999 (1) | WHO 2010 (2) |
|---|---|---|
| Semen volume (ml) | ≥2.0 | 1.5 |
| Sperm concentration ($10^6$/ml) | ≥20 | 15 |
| Total number ($10^6$/ejaculate) | ≥40 | 39 |
| Total motility (% a+b+c) | | 40 |
| Progressive motility (% a + b) | ≥50 | 32 |
| Morphology (% normal) | ≥14 | 4 |
| Vitality (% live) | 75 | 58 |
| White blood cells ($10^6$/ml) | <1.0 | <1.0 |

(1) WHO, 1999; Menkveld, 2010 (2) Cooper et al., 2009; WGO, 2010

## Minimal semen quality required for semen donors

- Castilla et al., 2007
  - Sperm concentration - ≥ 21.3 (58.0) x $10^6$/ml
  - Progressive motility - ≥ 50 (60) %
  - Progressive motile count - ≥ 42.6 (96.6) x $10^6$/ml
    - (For a <10% probability that the actual value will be less then the minimum required value)

## Minimum semen quality required for semen donors

- Björndahl et al., 2010
  - Sperm concentration - >50x$10^6$/ml
  - Progressive motility (a+b) - ≥ 40%
  - Morphology (% normal) - ≥ 14%(1)

(1) WHO, 1999

## Requirements for Post-Thaw semen quality

Number of motile spermatozoa per straw (NMSS)

- Barratt et al., 1998
  - No relationship between NMSS and IUI or IVF pregnancy rates
  - Minimal NMSS = 2.5x$10^6$
- Mortimer, 1994
  - 5x$10^6$ progressive motile spermatozoa/straw

## Requirements for Post-Thaw semen quality

- Yogev et al., 2004
  - 8x$10^6$ progressive motile spermatozoa/straw
    - (Will ensure minimum of 4x$10^6$ progressive motile spermatozoa/ 0.5 ml straw)
- Castilla et al., 2007
  - To ensure 8X$10^6$ progressive motile spermatozoa, actual numbers needed per straw must be:
  - Progressive motility of 25% = 28%
  - Sperm concentration of 32 x $10^6$/ml = 37 x $10^6$/ml
    - (For a <10% probability that the actual value will be less then the minimum required value)

## Requirements for Post-Thaw semen quality

- Post-thaw survival (PTS) and pregnancy rate
  - PTS ≤ 30% = 5.5%
  - PTS of 30-50% = 15.4%
  - PTS >50% = 27.2%
- Number of motile spermatozoa inseminated (NMSI)
  - NMSI of $<0.5x10^6$ = Pregnancies possible
  - NMSI between $1.5\text{-}25x10^6$ = Acceptable pregnancy rates
  - Optimal pregnancy rate with NMSI = $6\text{-}15x10^6$/ml

Barratt et al., 1998

## Post-thaw semen quality variability between donor sperm banks

| | Mean ± SD | Range | CV (%) |
|---|---|---|---|
| Total concentration ($10^6$/ml) | 164.8±3.6 | 97.3 – 264.0 | 86.7 |
| Total motility (% a+b+c) | 65.5±6.0 | 46.0 – 78.0 | |
| Motile count ($10^6$/ml) | 125.6±31.7 | 65.6 – 207.0 | |
| Progressive motility (% a+b) | 38.9±4.4 | 29.0 – 48.0 | 44.1 |
| Progressive motile count ($10^6$/ml) | 74.1±19.1 | 41.5 – 122.7 | 114.3 |
| Morphology (% normal - SC) | 20.3±2.1 | 16. 5 – 25.0 | 39.7 |

Carrell et al., 2002

## Variation in donor fertility

McGowan et al., 1983 (1)

- 177 donors – good semen quality
- 4 year follow-up
- Variation in pregnancy results
  - <5 to >20 pregnancies per 100 inseminations
- Analyzed semen parameters of 25 most fertile and 25 least fertile

## Variation in donor fertility

McGowan et al., 1983 (2)

| | 25 most fertile | 25 least fertile | *P*-value |
|---|---|---|---|
| Sperm concentration ($10^6$/ml) | 130 ± 67.8 | 104 ± 52 | N/S |
| Motility - before freezing (%) | 69 ± 4.3 | 68 ± 4.8 | N/S |
| Motility – post thaw | 52 ± 7.1 | 49 ± 6.2 | N/S |
| Morphology (% normal) | 76 ± 8.3 | 68 ± 9.4 | <0.01 |

Recommendation: Discard donors with no pregnancies in 12 cycles

## Source of variability between donors, speciments and measurements

Centola et al., 1992

- 12 – 47% due to speciment to speciment by doner
- 12 – 41 % due to measurement variability
- Also variability within donor semen samples with regard to freezibility

There was a relationship between motile sperm count after semen dilution and post-thaw motile sperm count

Good motile sperm count after semen dilution was a good indicator of semen freezibility

## Rate of donor acceptance

Only one out of ten men initially evaluated will qualify as a sperm bank donor

- Reasons
  - Lack of interest after interview
  - Issus for completing questionnaires, serology testing, medical history
  - Low semen quality
  - Poor post-thaw semen quality

Björndahl et al., 2010

## Possible negative influences on donor semen quality

- Environmental factors
  - Declining semen parameters
  - Lead
- Seasonal variations
- Effect of stress on semen quality of donors
- Effect of sperm functional tests

## Declining semen parameters and donors semen quality

Conflicting reports in literature

- No declining effect of semen parameters over years
- Decline of semen parameters over years

## No declining semen parameters

Costello et al., 2002

- Study period 1983 to 2001
- Linear regression results
  - Total sperm count (r = 0.065; *P* = 0.17)
  - Volume (r = 0.002; *P* = 0.97)
  - Sperm motility (found increase) (Spearman R = 0.194; *P* = 0.001)
- Conclusion
  - Semen quality of donors showed no decline

## Decline in semen parameters

Horák et al., 2008

- Study period 1982 to 2004
- Upper Silesia (Poland – high polluted area)

| | 1982 - 1995 | 1996 - 2004 |
|---|---|---|
| Donors (n) | 44 (Fresh samples) | 20 (Frozen samples) |
| Cycles | 1617 | 1994 |
| Couples (n) | 290 | 414 |
| Pregnancies (n) | 125 | 85 |
| Pregnancies per cycle (%) | 7.7 | 4.3 |
| Pregnancies per couple (%) | 43.1 | 20.5 |

Results – Needed more insemination and cycles per pregnancy (See Figure)

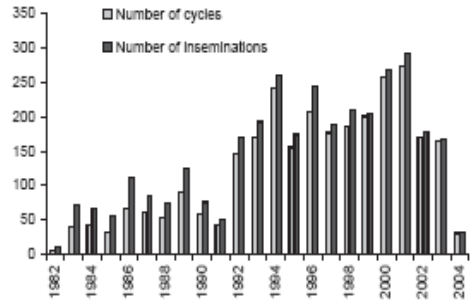
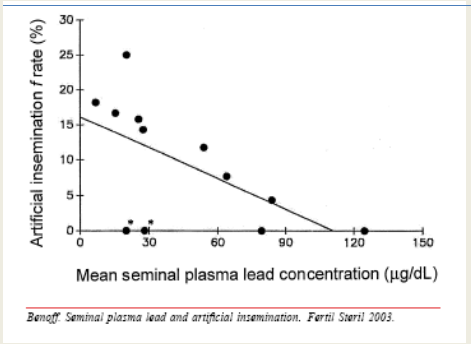



**Figure 1.** Number of cycles and inseminations in particular years 1982–2004.

Horák et al., 2008

## Effect of donor semen seminal plasma lead concentrations and IUI outcome




*Benoff. Seminal plasma lead and artificial insemination. Fertil Steril 2003.*

## Effect of seasons on donor semen quality

Yogev et al., 2004

- Fixed frozen semen aliquots (8-12x$10^6$/ml TPMSC) after thaw

| Number/season | Semen parameter | Highest | Lowest | *P*-value |
|---|---|---|---|---|
| Spring (n=92) | Sperm concentration | March/Dec | September | 0.030 |
| Summer (n=97) | Morphology | March/Dec | September | 0.038 |
| Autumn (n=81) | Volume | No effect | No effect | N/A |
| Winter (n=97) | Motility | No effect | No effect | N/A |

Freezibility drops significantly between March to December
• Consequence – Need more straws ($P$=0.017) due to less TPMSC per straw available ($P$=0.002)

## Effect of freezing and thawing on sperm functional abilities

Yogev et al., 2010

- Study design
  - 113 candidates tested to become semen donors
  - 16 active semen donors
  - Basic semen analysis, Hyaluronan-binding assay (HBA), sperm freezing and thawing
- Results
  - HBA was significant predictive for freeze-thaw outcome of ≥ 40%
  - 1 and 4 hour original motility >HBA for good freezability
  - Freeze-thaw had no influence on HBA

## Conclusions

- Recruitment of semen donors for donor sperm banks is tedious due high out fall rate
- There are no universal semen parameter guidelines for the selection of donors for sperm banks around the world
- Selection of the best donor is complicated by variation of semen parameters from donors due to biological (environmental influences and donor semen variability) and analytical variability
- Will appear that ideal number = 5-10 X$10^6$ motile sperm per straw (0.5 ml)


## References (1)

ABA, ACE, BAS, BFS, RCOG. UK guidelines for the medical and laboratory screening of sperm, egg and embryo donors (2008). Hum Fertil 11(4):210-210,2008

ASRM. 2006 Guidelines for gamete and embryo donation. Fertil Steril 86(Suppl 4):S38-50,2006

Barratt et al. Hum Reprod 13 (Suppl 2):1-11,1998

Benoff et al. Fertil Steril 80(3):517-25,2003

Björndahl et al. Practical guide to Laboratory Andrology. Cambridge University Press. 2010

Carrell et al., Fertil Steril 78(1):16-21,2002

Castilla et al., Cell Tissue Bank 8:257-56,2007

Centola et al. J Androl 13(3):283-8,1992

Cooper et al. Hum Reprod Update doi:10.1093/humupd/dmpo48,2009

## References (2)

Costello et al., J Assist Reprod Genet 19(6):284-90,2002

Edelstein et al., Fertil Steril 90(4):1327-30,2009

Horák et al., Ann Agric Environ Med 15(1):113-8,2008

McGowan et al., Clin Reprod Fertil 2:269-274,1983

Menkveld R. Asian J Androl 12:47-58,2010

Mortimer D. Practical Laboratory Andrology. Oxford University Press, 1994

Poland et al., Int J Fertil 31(3):229-31,1986

WHO Laboratory Manual for the examination of human semen and sperm-cervical mucus interaction. 4th ed. Cambridge University Press,1999

WHO Laboratory Manual for the Examination and processing of Human Semen. 5th ed. Geneva: World health Organization, 2010

Yogev et al., Hum Reprod 19(4):880-5,2004

Yogev et al. Fertil Steril 93(1),2010