Saliva control in Cerebral Palsy:
multidisciplinary management and research findings from the Australian and Dutch drooling team

AACPDM 67th Annual meeting
Milwaukee, October 16-19, 2013

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Disclosure Information
AACPDM 67th Annual Meeting October 16-19, 2013

Speakers Names: Jan van der Burg
Karen van Hulst

Disclosure of Relevant Financial Relationships
We have no financial relationships to disclose.

Disclosure of Off-Label and/or investigative uses:
We will not discuss off label use and/or investigational use in my presentation.

Speakers Names: Louise Baker
Sue Reid

Disclosure of Relevant Financial Relationships
We have the following financial relationships to disclose:

• Grant/Research support from Allergan Australia (Botox)

Disclosure of Off-Label and/or investigative uses:
We will discuss the following off label use in my presentation:

• BoNT-A

The Multidisciplinary Australian drooling team*

Paediatricians
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• Louise Baker MB Bch

Speech pathologists
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• Katherine Ong BAppSc

Dentist
• Mala Desai BDSc

Surgeon
• David Chong FRACP

Clinic co-ordinator
• Christine Westbury RN

Researcher
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*From left to right:
Rehabilitation Doctor:
• Dr. P. Jongerius, PhD
Psychologist:
• Dr. J. Van der Burg, PhD
Paediatric Neurologist:
• Dr. C. Erasmus, PhD
Speech pathologists:
• K. Van Hulst, MSc
• S. de Groot

ENT specialist:
• Dr. F. Van den Hoogen, PhD
• A. Schatter, PhD
• S. Kok

The multidisciplinary Nijmegen drooling team*

From left to right:
Rehabilitation Doctor:
• Dr. P. Jongerius, PhD
Psychologist:
• Dr. J. Van der Burg, PhD
Paediatric Neurologist:
• Dr. C. Erasmus, PhD
Speech pathologists:
• K. Van Hulst, MSc
• S. de Groot

ENT specialist:
• Dr. F. Van den Hoogen, PhD
• A. Schatter, PhD
• S. Kok
Role of the Speech Pathologist

- Facts about swallowing problems in children with CP
- Anterior and Posterior drooling
- Assessment
- Objective drooling measures
- Subjective drooling measures
- Intervention

Prevalence and predictors of drooling in children with CP

(Weighted) Prevalence of drooling
22% Parkes et al, 2010
39.6% Reid et al, 2012

Significant association drooling and ......
GMFCS level
Topographical pattern
Head posture stabilization

Epilepsy
Intellectual disability
Type of schooling
Oromotor function
Eating/speech difficulties


Drooling is a swallowing problem

Dysphagia:
- Inability to swallow drinks, food and medication efficient and safely
- Inability to swallow reflux material efficient and safely
- Inability to swallow saliva efficient and safely

Direct aspiration
Indirect aspiration
Anterior and posterial drooling/saliva aspiration

The role of saliva;

Saliva has seven main functions:
- Protect teeth and gums
- Prepares foods for chewing and swallowing
- Initiates carbohydrate digestion
- Lubricates tongue and lips for speech
- Assists with oral hygiene
- Regulates acidity
- Facilitates taste
Saliva production

• Daily saliva secretion: 500 ml – 1.5 litres
• Most produced by two pair of glands:
  - Submandibular (seromucous saliva): 60 - 70% in rest
  - Parotid (serous): 25% during eating, chewing
• Swallowing occurs:
  - in rest: 600 times a day (Leer 1965)
  - total (sleep, eating, rest): ca. 1200 times a day (Rudney & Larson 1995)
  - 0.3 – 6.7 x per minute
  - At night: 0 - 7 x per hour
• Drooling beyond the age of 4 is abnormal
• Drooling is a multifactorial problem

Anterior - Posterior drooling

Anterior drooling:
Saliva spilled from the mouth that is clearly visible

Posterior drooling:
Saliva spilled into the pharynx possibly creating a risk of aspiration

Consequences drooling

Anterior drooling
• Social rejection and isolation
• Lack of self confidence
• Stigmatizing, shame
• Damp and soiled clothes
• Intubated chapped skin
• Damage (communication devices, computers, furniture, books, etc)
• Interference with speech
• Unpleasant odour

Posterior drooling
Saliva contains bacteria and yeast which can cause:
• Recurrent respiratory symptoms
• Wheeze
• Chronic cough
• Choking
• Failure to thrive
• Radiological signs of chronic lung injury

Drooling: direct causes
Disturbed oropharyngeal swallow phase:
• Poor saliva bolus formation
• Inadequate lip closure
• Reduced frequency of swallowing
• Absent oropharyngeal sensation
• Hypo/hypertonia tongue, lips, cheek
• Disorganised tongue movements
• Delayed coordination of swallowing/dysphagia

Drooling: Indirect causes

• Inadequate posture (trunk/head)
• Retardation; cognitive level < 3 years
• Reduced awareness, not able to divide attention to double tasks
• Malocclusion
• Mouthing
• Medication
• Reflux (oesophageal saliva reflex)
• Dentition
Hypersalivation is no cause!

Hypersalivation?

normal salivation = mean 0.3 ml/min

Study Erasmus, van Hulst et al 2009: normal rest salivation of 0.34 ml/min in CP vs. 0.32 ml/min in Controls


Except in the subgroup children with dyskinetic CP...

SLT Assessment

History and patient’s goal for treatment

Posture and mobility

Orofacial examination and oral hygiene

Oral sensory motor functions and abilities

Communication and speech possibilities

Eating and drinking observation

Specific swallow and drooling measures

Self management strategies

Specific swallow measures

Swallowing on demand

Swallow frequency

Quality and safety of the swallow act

Tongue action during swallowing

Oral control

Cough reaction

Composition of saliva (mucous, serous, etc)

Drooling Severity and Frequency Scale (DSFS)

Severity

Frequency

1. Dry

Never drools

1. Never

2. Mild

Wet lips only

2. Occasionally

3. Moderate

Wet lips and chin

Not every day

3. Frequently

4. Severe

Wet clothes

Part of every day

5. Profuse

Wet clothing, hands, tray and objects

Constantly

Specific drooling measures (clinical and research tools)

Subjective reporting:

- Visual Analog Scale (VAS)
- Questionnaires/ Drooling Impact Scale
- Drooling Severity and Frequency Scale

Burg van der 2006, Reid 2010

Thomas Stommel & Greenberg 1988

Objective measures:

- Collection devices bibs/cups
- Drooling Quotient

Sochaniwskyj 1982

Rapp 1980, van Hulst 2012


Drooling Quotient: 5 minute version

A semi quantitative, direct observational method that evaluates drooling by measuring (new) leaked saliva from the lips.

Conclusion:
- DQ10 and DQ5 can be used interchangeably
- DQ5 is reliable, accurate, and time efficient
- The DQ during activity is most discriminative for drooling severity
- A clear cut-off point can be used to support clinical decision making


How to measure posterior drooling?

Mostly by clinical signs:
- Cervical auscultation

Diagnostics
- FEES (fiberoptic-endoscopic evaluation of swallowing)
- Saliva is not visible during videofluoroscopic study

Interventions drooling

**Anterior drooling**
- Oro-motor, oro-sensory therapy
- Behavioral therapy
- Intra-oral appliances
- Pharmacologic treatments
- Surgery

**Posterior drooling**
- Physical and dysphagia treatment
- Pharmacologic treatments
- Surgery
- Radiotherapy

Cochraine review (Walshe et al. 2012)
- Lack of consensus regarding which interventions are most effective for children with CP.
- Pharmacologic treatments (BoNT-A, anticholinergics)
- Surgery
- Behavioral therapy
- Intra-oral appliances
- Conservative, oro-sensory motor therapy

Oro-sensory motor therapy

- Take care of conditions (adequate posture, reflux treatment, no caries, no ENT problems, etc)
- Oro- Motor therapy to improve lip and jaw closure, increasing tongue and oral control, reduce tongue thrust, etc
- Improve oral perception, awareness (Is my chin dry?)
- Learn slurp-swallow on demand (“swallow factory”)
- Improve swallowing frequency
- Learn to stay dry (wiping, swallowing)
- Eating and drinking therapy

Behavioral therapy for drooling

- Drooling defined as behavior problem: too little swallowing, too little wiping, etc.
- Intervention goal: increasing the frequency of swallowing and/or wiping
Behavioral procedures for drooling

Five types of procedures have been proven effective:
1. instruction, prompting en positive social reinforcement
2. negative social reinforcement and other ‘declarative’ procedures
3. automatic cueing
4. automatic reinforcement (microswitch-based technology)
5. self-management procedures


Behavioral procedures for drooling: from external to internal control

Intervention techniques:
• Antecedent control
• Consequent control
• Combination (antecedent and consequent control)
• Self-management

Examples of behavioral procedures

Instruction
• e.g. ‘Wipe your face when wet’

Prompts
• Auditory/verbal, visual or tactile cues from a trainer, parent or teacher

Automatic cueing
• Auditory, visual or tactile cues at set time intervals from a portable device

Positive feedback
• Positive remark, token (sticker)

Automatic reinforcement
• Music after activation of microswitch in bib

Negative feedback
• Negative remark

Declarative procedures
• Overcorrection: wipe chin and mouth 10 times after being wet

Behavioral therapy for drooling

Two treatment protocols:
• Self-management
• Automatic tactile cueing

Self-management training for drooling: case-series 1

• Inclusion criteria
• Setting
• Method
  - Dependent variable (latency and VAS) & design
  - Treatment procedure
    - Instruction -> self-instruction
    - Positive/negative feedback -> self-evaluation and self-reinforcement
    - Gradual increase of time interval
Conclusions from case series 1

- Participants learn to apply the self-care-routine and manage to stay dry during daily activities for intervals of 30-60 minutes
- Parents and teachers report changes in self-care and reduced drooling at home and at school (VAS) after discharge
- Latency-scores FU 6 & 24 weeks: 3 participants effects maintained; 5 children decrease to baseline-level
- VAS-scores (parents & teachers) FU 6 & 24 weeks: positive effects at home and at school, compared to baseline

Generalization & maintenance should be improved!

Self-management training for drooling: case-series 2

Procedural additions to promote generalization & maintenance:

- Personal motivation child made explicit
- Differential evaluation and reinforcement of (1) swallowing, (2) controlling and (3) wiping the mouth/chin area
- Parent/teacher instruction and feedback
- 4 post-intervention sessions:
  - 2x phone consults (3 & 12 weeks after discharge)
  - 2x school visits (6 & 24 weeks after discharge)
Conclusions from case series 2

- 9 (from 10) participants learn to apply the self-care-routine and manage to stay dry during daily activities for intervals of 30-45 minutes
- Parents and teachers report changes in self-care and reduced drooling at home and at school (VAS) after discharge
- Latency-scores FU 6 & 24 weeks: 3 (from 9) participants effects maintained; 2 children decrease to baseline-level
- VAS-scores (9 parents & teachers) FU 6 & 24 weeks: positive effects at home and at school, compared to baseline

Overall conclusions on self-management

- Self-management program appears effective for a selected subgroup of children
- Instructing parents and teachers makes them independent from professional trainers in case of relapse/increase of drooling
- Maintenance appears dependent on personal factors (e.g., motivation, degree of (oral)motor problems) and environmental factors (e.g., attitude, motivation)
- Latency scores are stern: not only a decrease in frequency and severity of drooling, but non-drooling is the target!

Behavioral therapy for drooling

Two treatment protocols:
- Self-management
- Automatic tactile cueing

Automatic tactile cueing: devices

Prototype 1
Prototype 2
Prototype 3

Automatic tactile cueing: procedure

1. Introduction of cueing device in training setting (outside classroom)
2a. Teach the child to swallow on the cue (instruction, modeling, positive social reinforcement)
   If 2a is not successful:
2b. Teach the child to wipe the mouth/chin on the cue (instruction, modeling, most-to-least prompting, positive social reinforcement)
3. Implementation of cueing device in the classroom at set times
4. Implementation of cueing device in the classroom throughout the day
5. Implementation of cueing device at home

Some results from our N=1 studies

Results up to now are variable:
- A boy with CP (CA 15y; DA 2-3 years) learned to wipe his mouth on the tactile cue, and remained dry at school and at home, even when he was not wearing his cueing device anymore.
- After 20 one-to-one training sessions, a girl with a non-classified syndrome (CA 8y; DA 20 months) appeared not to be able to wipe her mouth on the tactile cue.
- A boy with CP (atactic type, bilateral spasticity) and mild intellectual disability (CA 8y; IQ 63) learned to swallow on the tactile cue, but after introduction of the cueing device in the classroom and at home, this effect slowly disappeared.
Behavioral procedures for drooling: analysis of studies

Conclusions from reviews (Van der Burg et al., 2007a,b, 2013):

• Instructions, prompts, feedback & reinforcement: systematic implementation
• Cueing interventions: children remain dependent on the device
• Microswitch technologies: severe-to-profound range of ID
• Negative reinforcement and decelerative procedures: avoid if possible
• Self-management: maximum independence; re-training/procedural changes necessary for generalization & maintenance; contraindicated severe/profound ID or DA before 6 yrs


Drug therapy

• Oral medication (anticholinergics)
  • Benzhexol hydrochloride (Artane)
  • Glycopyrrolate (Robinul)

Usage:
• In young children where maturation of oral function may still occur
• In older children and adults with relatively mild saliva control problems
• As an alternative to surgery for those who prefer a non-operative approach

Drug therapy - dosage

• Benzhexol hydrochloride
  • 1 mg twice daily for 1-2 weeks
  • 2 mg twice daily for 1-2 weeks
  • 2 mg up to 3-4 times daily
Drug therapy - dosage

- Glycopyrrolate
  - 0.01 – 0.04 mg / kg per dose
  - 10-15 kg
    - 0.25 mg bd, 10.5 mg bd, 11 mg up to tds
  - 15 kg – 25 kg
    - 0.5 mg bd, 11 mg bd, 11 mg tds
  - ≥ 25 kg
    - 1 mg bd, 11 mg tds, 1.5 mg tds

Drug therapy - research evidence

- Benzpropin
  - 27 patients (7 dropped out)
  - Positive effect on drooling
    (Camp-Bruno 1989)

- Benzhexol
  - 20 children aged 3 – 12 years
  - 17 children showed improvement in drooling
  - Side effects were minimal
    (Reddihough 1990)

Intraoral appliances

- The ISMAR (Haberfellner)
  - Innbruck Sensory Motor Activator and Regulator
  - Stabilizes jaw to facilitate lip and tongue movements
  - Worn for short periods each day then overnight

Drug therapy – research evidence

- Glycopyrrolate
  - RCT of 39 patients (4-19 years)
  - 12 children did not complete study
  - Overall improvement
    (Mier et al 2000)
  - Open label study of 40 patients (4-27 years)
  - Drooling improved in most
    (Blasco & Stansbury 1996)
  - Retrospective trial in 54 children
  - Most improved but 50% had adverse effects
    (Bachrach et al 1998)

Glycopyrrolate: recent papers

ISMAR studies aims

To determine whether
- the ISMAR is an effective intervention to improve drooling in children with CP
- we could identify any factors to indicate which children were good candidates for this type of therapeutic approach


ISMAR study methods

- Subjects: 18 children, 4-11y with mild-severe CP, dysphagia, drooling (14 wheelchair dependent)
- Three phases of 6 months
  1. Control phase
  2. Stabilisation phase
  3. Mobilisation phase
- Assessments and dental impressions performed at start of each phase and completion of project

ISMAR study measures

- Frequency and severity of drooling measured
  - Thomas-Stonell & Greenberg
- Eating and drinking skills assessed using Functional Feeding Assessment (modified)
  - Gisel
- Compliance an issue
  - only 6/18 completed study

Severity of drooling

<table>
<thead>
<tr>
<th>Severity</th>
<th>Dry</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Profuse</th>
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<tbody>
<tr>
<td>Control</td>
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<tr>
<td>Stabilisation</td>
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<td>Mobilisation</td>
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Change in eating and drinking skills

- Control
- Treatment

- Spoon feeding
- Biting
- Chewing
- Cup drinking
- Straw drinking
- Swallowing
Conclusions
ISMAR study
• Careful candidate selection is necessary
• Prolonged illness, surgery, seizures and intolerance of appliance led to many withdrawals
• Good cognitive function and motivation were key to successful outcome

Botulinum toxin (BoNT-A)

Background
• 75% of salivation mediated by cholinergic neurotransmitters
• BoNT-A blocks release of acetylcholine
• Within 1-3 days BoNT binds to nerve endings and reduces amount of saliva produced

Methods used
• In Melbourne, submandibular and parotid glands injected under ultrasonic guidance and G.A.
  • Dosage: 25 units per gland diluted to 1ml to a maximum dose of 4 units per Kg (Total of 100 units in 4ml in children >25kg)
  • In The Netherlands submandibular glands injected initially
    • If good response, injection into submandibular glands is repeated.
    • If poor response, combined submandibular and parotid glands injections considered (or one of the other treatment options).
Aims:
• To assess effectiveness of BoNT-A injections into submandibular and parotid glands for anterior drooling in children with CP and other neurological disorders
• To ascertain timing of maximal response and duration of effect


Intervention
• 100u BoNT-A diluted into 4 mls normal saline
• Under short ga and ultrasonic guidance, 1 ml injected into each gland
  • 25u per gland OR
  • 4u per kg if child < 25kg

Study methods
• Unblinded RCT, parallel groups
  • Sample size 28 per group
  • Follow-up for 6 months
  • Controls received no treatment but eligible for treatment at end of follow-up
  • Collected information on demographics, current medications, general health, side-effects
  • Main outcome measure: Drooling Impact Scale (DRI Scale) at baseline and monthly for 6m
Progress through study

**Enrolment**
- Allocated to intervention n=26
- Received intervention n=24
- Received no intervention n=24
- LTFU n=0
- Discontinued n=0

**Randomisation**
- Allocated no intervention n=24
- Received no intervention n=24
- Analysed n=24
- Excluded n=0

**Follow-up**
- Analysed n=23
- Excluded n=1 (incomplete)

Results: DrI Scale scores

![DrI Scale scores graph](image)

Results: Duration of response

![Duration of response graph](image)

Results: Summary

- 4/24 children had no response at 1m
- < 10 point reduction on DrI Scale
- 4/24 children had mediocre response
- 10-20 point reduction on DrI Scale
- 67% response rate
- Greatest response at 1m
- At 6m difference between control and treatment groups remained significant

Dutch BoNT study

- **Participants**: 131 children with CP or other neurological disorder with mod-severe drooling
- **Intervention**: BoNT-A to submandibular glands
  - 15 U per gland for children <15 kg
  - 20 U/gland for children weighing 15-25 kg
  - 25 U/gland for children weighing >25 kg
- **Outcomes**: Drooling Quotient and caretaker VAS
- **Results**: 47% response rate for median of 22w


Side effects noted

- Problems with swallowing (both studies)
  - 1 significant and 3 minor (17%) in Melbourne study
  - 3% minor in Dutch study + 6% deterioration in feeding
- 1 chest infection and 1 first seizure in Melb
- Changes in saliva consistency (both studies)
  - 41% had thickened saliva in Dutch study
  - 12% reported reduction in viscosity
- Improvements in handling of secretions, speech, feeding behaviour (both studies)
Conclusions

• These studies support use of BoNT-A injections into submandibular +/- parotid glands in children with CP and other neurological disorders for management of drooling in approx. 50-67% cases
• Remained difficult to predict which children would respond and which children would experience unwanted side effects
• Response to repeat doses still unknown

Dutch study on saliva consistency

• 15 children: spastic or dyskinetic quadriplegic CP, GMFCS IV-V, mod-severe drooling
• Mucin concentration of saliva analysed pre and post BoNT-A.
• 9 children had thickened saliva.
• 7 had swallowing and chewing problems
• 2 needed treatment with mucolytics due to pooling of thickened saliva in throat


Secondary effects of BoNT-A

Aims:
• To assess the secondary benefits and side effects of BoNT-A injections into parotid and submandibular glands in children with developmental disability
• To determine whether these effects are related to reduction in drooling

Study methods

Participants
• 26 children were injected (14 males, 12 females, mean age 11y 3mo)
Pre and post assessments
• Drooling Impact (DrI) Scale
• Secondary effects questionnaire
  • Eating, speech, saliva management, sleep

Results

• Over 4 weeks, improvement seen for entire group for drooling ($p<0.001$), eating ($p=0.05$), speech ($p=0.04$), and sleep ($p=0.01$)
• No improvement in ability to manage saliva
• Graph shows decrease in drooling

Relationship b/t drooling response and changes in eating and sleep
Conclusions

- Improvement in eating skills and sleep occurred in the children whose drooling also improved.
- Deterioration in eating skills occurred in a minority whose drooling did not improve.
- Hypothesised that may be related to accuracy in locating middle of gland.
- Need to ensure child has adequate swallowing to allow for unforeseen deterioration.

Consensus statement

- Avoid BoNT-A if
  - Given in previous 3 mo
  - Patient has formed antibodies
  - Patient unfit for anaesthesia
- Limit adverse events by
  - Ultrasonic guidance
  - Observation for 2 hrs, regular contact first wk
  - Moist or pureed food over first wk
  - Be aware of swallowing/respiratory problems

Saliva control surgery

Potential options:
- Excision of the salivary glands
- Ligation of salivary ducts
- Relocation of ducts

Submandibular Duct Relocation

- First reported by Ekedahl (1974).
- Crysdale’s (1989) 194 patients
  - 20% excellent
  - 47% good
  - 22% fair
  - 11% poor
- 8% developed ranulae
- 2% need for submandibular gland excision due to obstruction/cyst formation.

Current practice

- In Melbourne we perform a combination of bilateral submandibular duct transposition (BSMDT) and bilateral sublingual gland excision (BSLGE)
- Additional parotid duct ligation performed occasionally
- In The Netherlands standard surgery is submandibular duct relocation +/- sublingual excision, or duct ligations
Melbourne surgical study

- Studied 72 children who had BSMDT and BSLGE between 1993 and 2001
  - 53% CP; 38% ID; mean age 10.4y (4 - 19)
  - Children assessed pre-op then at 1m, 6m, 12m, 2y, 5y post-op
- Outcome measures
  - Drooling Severity and Frequency Scale
  - No. bib/clothing changes

Other results
- Bib/clothing changes fell from 4 to 0
- Nearly half had 2 point drop on severity scale
- Frequency and severity maintained at 5y
- 5 had further surgery
- 13 complications
  - 7 major bleeding/swelling

Surgery compared to BoNT-A
- Children with severe drooling where surgery performed after BoNT-A
- DQ reduced to a greater extent after BSMGT and BSLGE than after BoNT-A (p=0.001)
  - DQ equivalent at baseline
  - DQ 10 v 18 at 8 wks
  - DQ 4 v 22 at 32 wks

Duct ligation alone
- 21 Dutch children underwent either 2 (SMx2), 3 (SMx2+Px1), or 4 (SMx2+Px2) duct ligation
- Less invasive
- Good results short-term
- Long term results not established

Case history “Rose”
- Case description
- Assessment
- Treatment history
- Current situation
- Discussion
- Final conclusion
- Take home message

Case history “Sarah”
- First presented at 4 years
- Cerebral palsy GMFCS V
- Poor feeding skills
- No expressive language
- Good understanding
- Initial treatment???

Case history “Sarah”
- Re-presented at 6 years
- Some improvement in feeding skills, still drooling ++
- Ongoing speech pathology
- Being teased at school
- What next??
Case history “Sarah”
- Reviewed at 9 years
- Medication trialled only for a short time
- Developed adverse effects
- Still some ongoing speech pathology
- Now has communication device
- Becoming more aware of problem herself and wants it “fixed”
- Intervention??

Case history “Sarah”
- Reviewed at 17 years prior to transition
- Had surgery at 12 years
- Good result
- Dentist monitoring dental status
- Participating well in home and community life

Comprehensive Resource Book
- Saliva Control in Children
- Website:
  http://www.rch.org.au/emplibrary/plastic/salivabook

Thank you