Perspectives des autorités de santé et modèle à compartiments

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Les spécificités du vaccin (1)

- Un contexte décisionnel particulier :
  - Des instances d'évaluation spécifiques (CTV, HCSP, à l'instar de nombreux pays)
    - Un statut particulier du vaccin ?
    - Des compétences particulières ?
    - Focus sur la stratégie plutôt que sur le produit
  - L'évaluation économique reconnue comme critère de décision [Cf. texte définissant les missions du CTV]
    - Les premières évaluations publiées concernaient la vaccination
    - Rapport coût / efficacité des vaccins (faible coût des vaccins, maladies très sévères, peu d'alternatives)
    - Un contexte qui se modifie [au regard de la population cible, du coût des vaccins, du fardeau des maladies, des stratégies alternatives]

L’accès au marché

Comité Technique des vaccinations (CTV)

↓

Haut Comité de la Santé Publique (HCSP)

⇄

AFSSAPS / EMEA (AMM)

↓

HAS (CT)

↓

Comité Économique des produits de santé (CEPS)

↓

Ministre de la santé

Les spécificités du vaccin (2)

- L'existence d'externalités :
  - La vaccination a des effets directs et indirects positifs [réduction de la circulation du pathogène au sein de la population] ou négatifs [déplacement en âge des cas, remplacement sérotypique]
  - Ces effets doivent être pris en compte dans l'évaluation afin de ne pas sous- (ou sur-) estimer les bénéfices associés à la vaccination

EXTERNALITES → CHOIX DU MODELE

Les spécificités du vaccin (3)

- Les effets de long terme :
  - La vaccination produit des effets de long terme (retour à l'équilibre du système). Le choix de l'horizon temporel est déterminant dans le processus d'évaluation [effets de lune de miel]
    - Quelle pertinence du point de vue du décideur ?
    - Prise en compte de l'incertitude ?
    - Quelle est la valeur présente des bénéfices et des coûts survenant à long terme ? [Actualisation]

EFFETS DE LONG TERME →

HORIZON TEMPOREL
INCERTITUDE
ACTUALISATION

La place de la modélisation dans l’évaluation dans l’évaluation des stratégies vaccinales

Qu'est-ce qu'un modèle ?

- Un modèle = représentation mathématique simplifiée de la réalité qui permet d'aller au-delà des données fournies par les essais cliniques
- Un modèle → arbitrage entre réalisme et complexité (sous la contraintes des connaissances du moment et des données disponibles)
- Le modèle permet de mettre en cohérence les données disponibles, de nature diverse (clinique, épidémiologique, sur l'observance et/ou la persistance, économique…)
- Le modèle permet de quantifier l'incertitude

Les différents types de modèles

Statique	Dynamique
Ouvert	Fermé
Déterministe	Stochastique
Agrégé	Individu-centré
Temps discret	Temps continu

Le choix du modèle

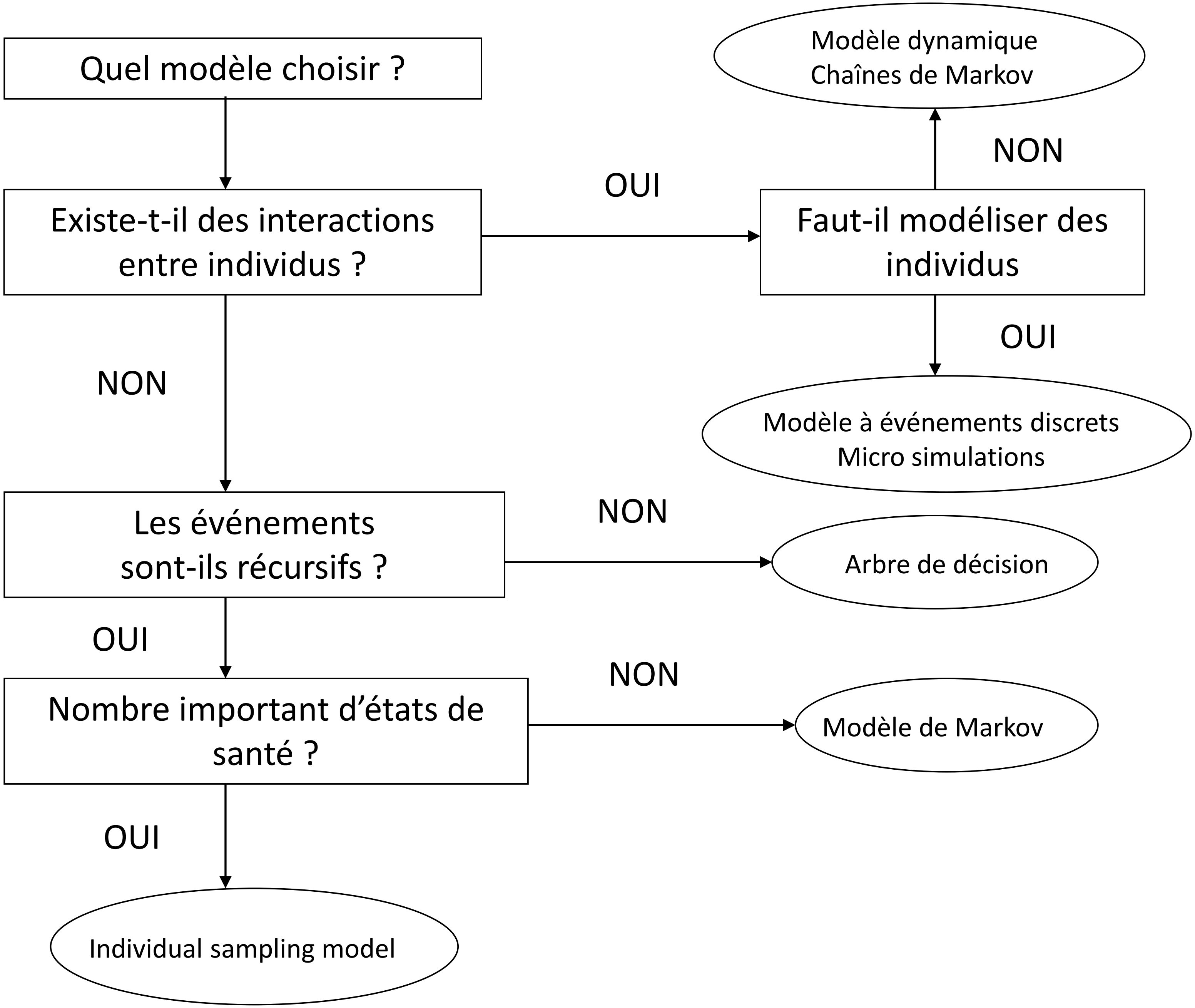
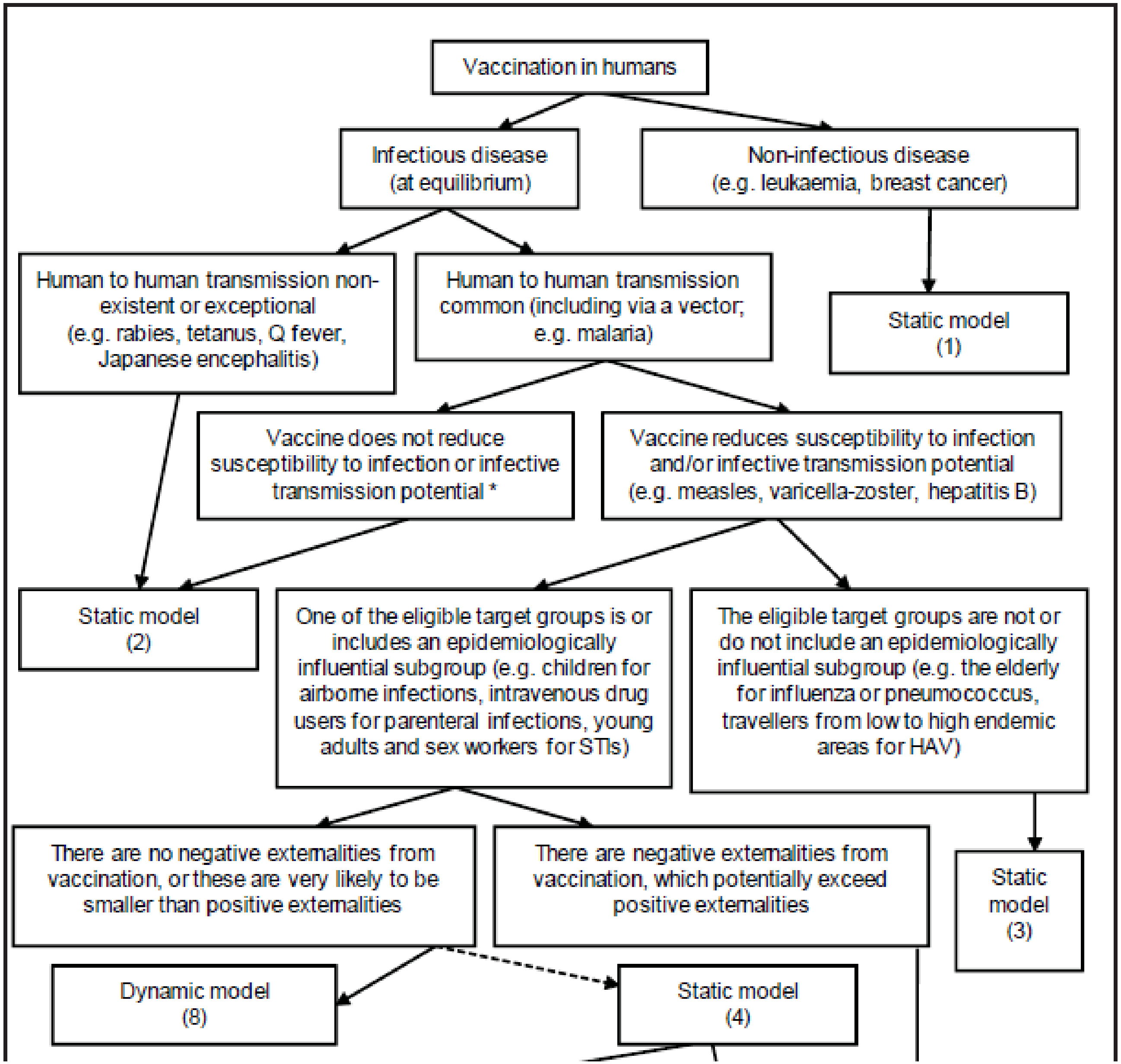
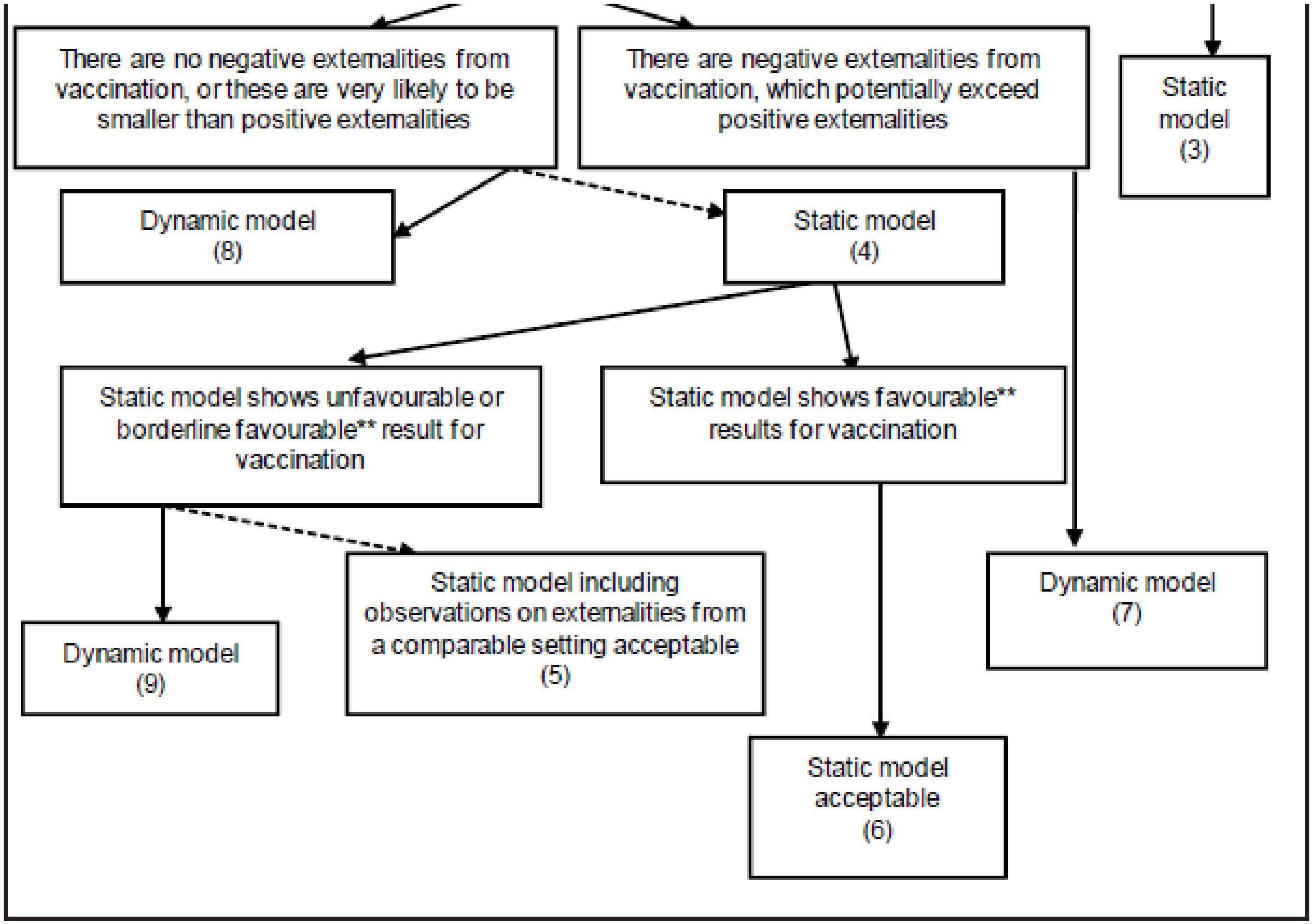
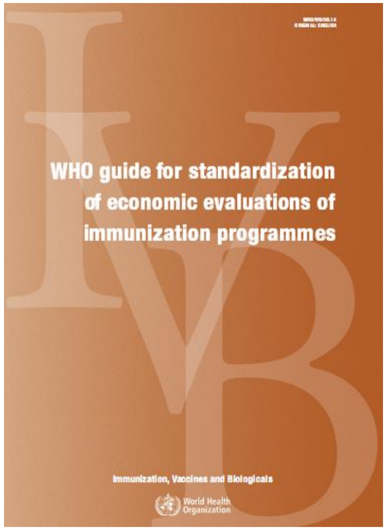

Quel modèle choisir ?
Existe-t-il des interactions entre individus ?
OUI
Faut-il modéliser des individus
NON
Modèle dynamique
Chaînes de Markov
OUI
Modèle à événements discrets
Micro simulations
NON
Les événements sont-ils récursifs ?
NON
Arbre de décision
OUI
Nombre important d'états de santé ?
NON
Modèle de Markov
OUI
Individual sampling model

Figure 3: Flow chart to help determine when dynamic or static models are appropriate




There are no negative externalities from vaccination, or these are very likely to be smaller than positive externalities
There are negative externalities from vaccination, which potentially exceed positive externalities
Static model (3)
Dynamic model (8)
Static model (4)
Static model shows unfavourable or borderline favourable** result for vaccination
Static model shows favourable** results for vaccination
Dynamic model (9)
Static model including observations on externalities from a comparable setting acceptable (5)
Dynamic model (7)
Static model acceptable (6)

Recommandations OMS (2008)



6.5 Recommendations

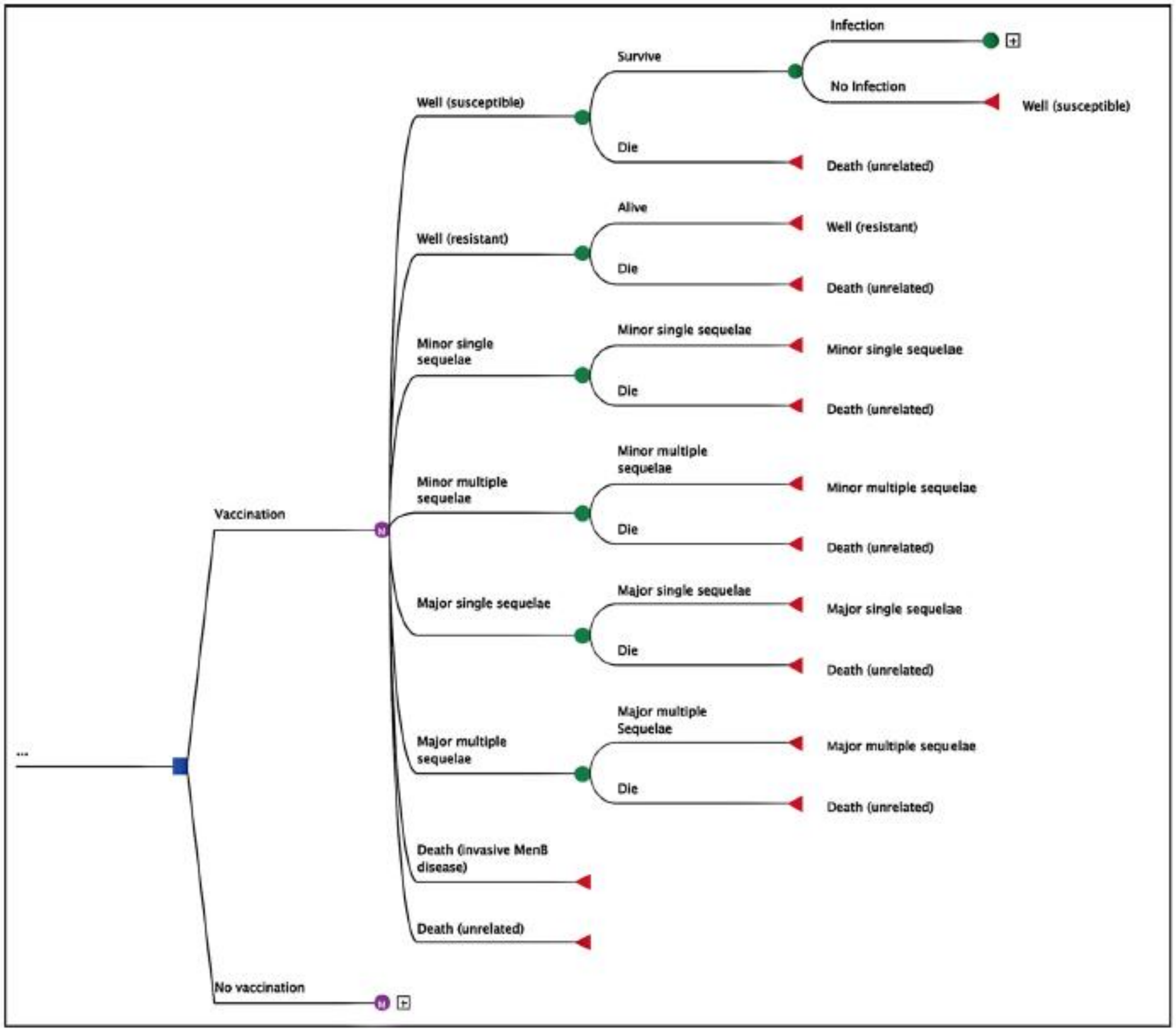
The mathematical model should be:

- Transparent in that the structure and implicit or explicit assumptions are all clearly described.
- Static, if vaccination is unlikely to change the force of infection in susceptibles or as a means to make a conservative estimate when externalities from herd-immunity cannot on the whole be adverse.
- Dynamic, if vaccination is likely to change the force of infection in susceptibles, and a static model would not yield a conservative estimate, or if the conservative estimate from a static model does not lead to an outcome which would be considered favourable by decision makers.
- Stochastic if chance plays an important role in the transmission process of the pathogen
- Validated, in as many facets of validation (verification, calibration, face validity, predictive validity) as possible, but at least verified.

Un exemple

Economic evaluation of meningococcal serogroup B childhood vaccination in Ontario, Canada

Hong Anh T. Tu[a], Shelley L. Deeks[b,c], Shaun K. Morris[d,e], Lisa Strifler[f], Natasha Crowcroft[b,c], Frances B. Jamieson[b,g], Jeffrey C. Kwong[b,c,h,i,j], Peter C. Coyte[a,k], Murray Krahn[a,j,k,l], Beate Sander[a,b,h,k,*]



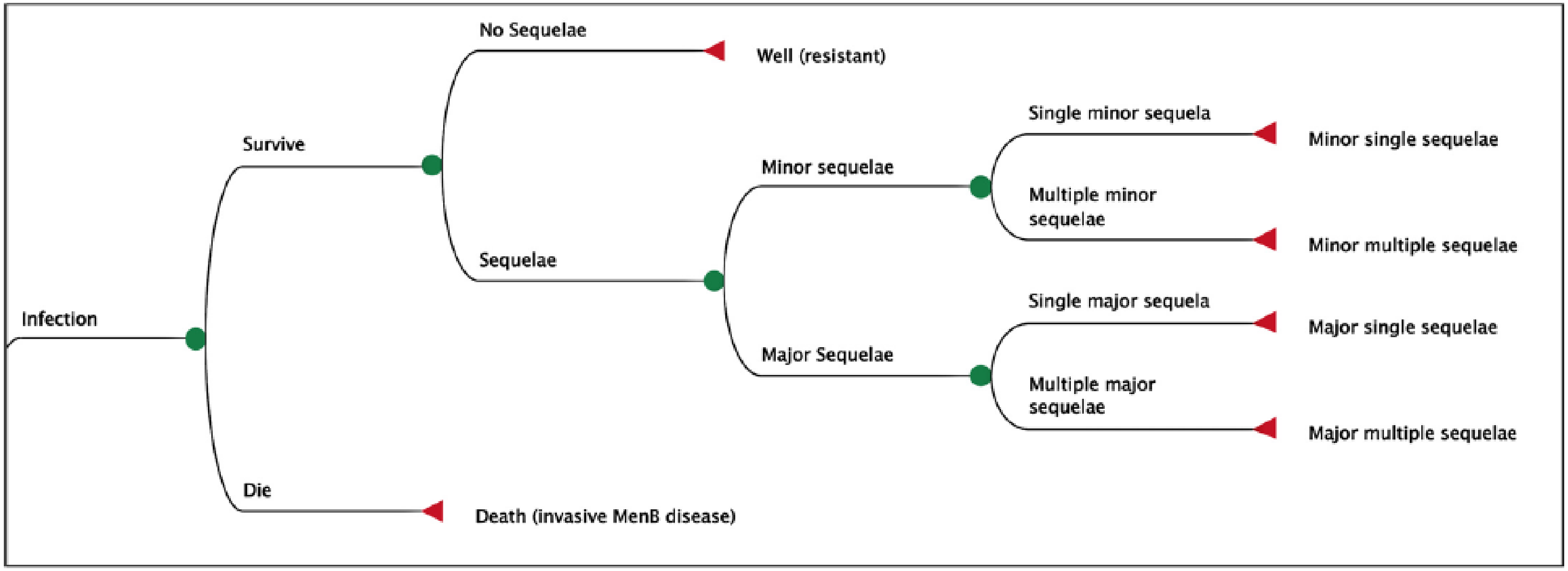

Infection
Survive
Die
Death (invasive MenB disease)
No Sequelae
Well (resistant)
Sequelae
Minor sequelae
Major Sequelae
Single minor sequela
Minor single sequelae
Multiple minor sequelae
Minor multiple sequelae
Single major sequela
Major single sequelae
Multiple major sequelae
Major multiple sequelae

Table 2
Base-case results for MenB vaccination versus no vaccination, undiscounted, discounted at 3% and discounted at 5%.

	No vaccination	Vaccination	Difference
Invasive MenB cases	23.04	18.49	−4.55
Invasive Men B related deaths	2.46	1.98	−0.48
QALYs			
Undiscounted	11,193,981	11,194,020	39.02
Discounted at 3%	4,316,396	4,316,411	14.93
Discounted at 5%	2,862,745	2,862,755	9.76
Cost of vaccination program (C$)	0	46,269,000	46,269,000
Cost related to vaccine adverse events (C$)	0	318,383	318,383
Treatment costs of invasive MenB cases (C$)[a]			
Undiscounted	1,491,950	1,128,556	−363,394
Discounted at 3%	767,055	579,935	−187,119
Discounted at 5%	631,522	480,999	−150,522
Total cost (C$)			
Undiscounted	1,491,950	47,715,939	46,223,989
Discounted at 3%	767,055	47,167,318	46,400,264
Discounted at 5%	631,522	47,068,383	46,436,861
ICER (C$/QALY)			
Undiscounted			1,184,482
Discounted at 3%			3,108,522
Discounted at 5%			4,756,189

C$, Canadian Dollar; ICER, Incremental cost-effectiveness ratio; QALY, quality-adjusted life year.
[a] Treatment costs include public health cost for contact management as described in Section 2.2.4.

Cost-effectiveness of vaccination against meningococcal B among Dutch infants

Crucial impact of changes in incidence

Koen B. Pouwels,[1,*] Eelko Hak,[1] Arie van der Ende,[2,3] Hannah Christensen,[4] Germie P.J.M. van den Dobbelsteen[5,†] and Maarten J. Postma[1]

Table 1. Influence of increasing the incidence of meningococcal B disease on the cost-effectiveness of routine infant vaccination with different vaccination strategies

Vaccination schedule	Base-case incidence* (€/QALY)	Incidence '90-'93* (€/QALY)	Incidence per 100,000 person-years needed to stay below €20,000/QALY[a]	Incidence per 100,000 person-years needed to stay below €50,000/QALY[a]
2, 3, 4, 11 mo	243,778	85,931	12.58	5.72
2, 3, 4, 11 mo + 12 y	247,139	77,392	11.49	5.19
12 + 14 mo	221,132	70,898	10.60	4.79
12 + 14 mo + 12 y	234,548	66,811	10.08	4.53

*Base-case incidence was 1.07 per 100,000 person-years; Incidence of '90-'93 was 3.46 per 100,000 person-years. aUsing the meningococcal B disease age-distribution of '90-'93.

Vaccinating adolescents against meningococcal disease in Canada: A cost-effectiveness analysis

Philippe De Wals [a,*], Laurent Coudeville [b], Pierre Trottier [c], Catherine Chevat [b], Lonny J. Erickson [d], Van Hung Nguyen [b]

Vaccine
www.elsevier.com/locate/vaccine

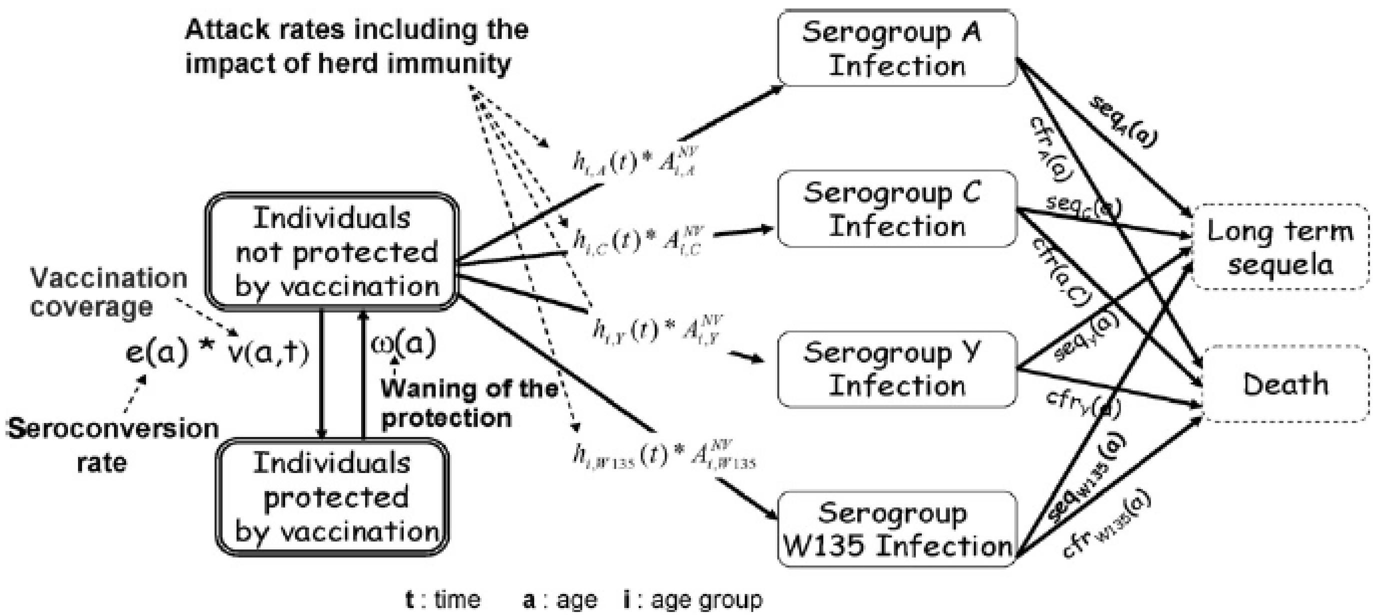


Fig. 1. Schematic representation of the simulation model.

$$h_i(t) = h_0 \sum_j z_{ij} \; V_j(t) \quad \text{avec} \quad \sum_j z_{ij} = 1 \quad \forall i$$

$$avec \; z_{ij} = \frac{a_{ij} \; c_j \; N_j}{\sum_k a_{ik} \; c_k \; N_k}$$

La paramétrisation du modèle

Herd immunity from meningococcal serogroup C conjugate vaccination in England: database analysis

Mary E Ramsay, Nick J Andrews, Caroline L Trotter, Edward B Kaczmarski, Elizabeth Miller

Attack rate of confirmed meningococcal serogroup C infection in unvaccinated children before and after the launch of the vaccination campaign

	July 1998-June 1999				July 2001-June 2002					
Cohort	Date of birth	Cases	Population	Attack rate per 100 000 (95% CI)	Date of birth	Cases	Estimated coverage (%)	Estimated population	Attack rate per 100 000 (95% CI)	% reduction (95% CI)*
Adolescent	1 Sep 1978 to 31 Aug 1981	96	1 818 034	5.28 (4.2 to 6.3)	1 Sep 1981 to 31 Aug 1984	11	66	614 110	1.79 (0.7 to 2.8)	66 (37 to 82)
School years 7-10	1 Sep 1981 to 31 Aug 1985	141	2 546 938	5.54 (4.6 to 6.4)	1 Sep 1984 to 31 Aug 1988	4	86	359 118	1.11 (0.02 to 2.2)	80 (46 to 93)
School years 1-6	1 Sep 1985 to 31 Aug 1991	76	3 911 606	1.94 (1.5 to 2.4)	1 Sep 1988 to 31 Aug 1994	5	87	498 068	1.00 (0.1 to 1.9)	48 (−28 to 79)
Preschool	1 Sep 1991 to 31 Dec 1994	81	2 055 120	3.94 (3.1 to 4.8)	1 Sep 1994 to 31 Dec 1997	6	76	501 449	1.20 (0.2 to 2.2)	70 (30 to 87)
Toddlers	1 Jan 1995 to 31 Dec 1995	41	601 045	6.82 (4.7 to 8.9)	1 Jan 1998 to 31 Dec 1998	2	84	97 369	2.05 (−0.7 to 4.9)	70 (−24 to 93)
Infants	1 Jan 1996 to 28 Jul 1996	24	320 562	7.49 (1.5 to 10.5)	1 Jan 1999 to 28 Jul 1999	1	80	64 112	1.56 (−1.5 to 4.6)	79 (−54 to 97)
Overall		459	11 235 305	4.08 (3.7 to 4.5)		29		2 134 226	1.36 (0.86 to 1.85)	67 (52 to 77)

*95% confidence intervals were estimated by using the Taylor series method for relative risks.

range of 48% to 80% across the age groups (table). A smaller fall occurred in adults not eligible for vaccination (aged ≥25 years), for whom the incidence declined by 35% (20% to 49%) from 0.53 (193/36 315 726) to 0.34 (123/36 315 726) per 100 000.

Epidemiological impact and cost-effectiveness of vaccination against meningococcal B disease in France

Héloïse Lecocq [1], Isabelle Parent [2],
Muhamed-KheirTaha [3], Daniel Lévy-Bruhl [2], Benoit Dervaux [1]

1 EA 2674, Lille University School of Medicine, France
2 French Institute for Public Health Surveillance (InVS), Saint-Maurice, France
3 National Reference Centre for Meningococci, Pasteur Institute, Paris, France

ESCAIDE 7 November 2014

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Base case : impact of vaccination assuming direct effects only (vaccine price = 40 €) – at stationary level

Vaccination strategy	# cases / year	# cases prevented / y	# deaths prevented / y	Cost per QALY gained (€)
Reference (no vaccination)	524			-
Routine vaccination strategy only				
3, 5, 6 m + 13 m (A)	432 (-18%)	92	9	386,443
13, 15 m + 27 m (B)	462 (-12%)	62	6	520,110
15 y (C)	495 (-5%)	29	2	629,488
Routine + Booster + Catch-up strategy				
3,5,6 m+13 m +15y + C-up (D)	405 (-23%)	119	11	406,889
13,15 m+27m +15y + C-up (E)	435 (-17%)	89	8	522,273

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Sensitivity analysis: impact of vaccination assuming herd immunity (vaccine price = 40 €) – at stationary level

Vaccination strategy	# cases / year	# cases prevented / y	# deaths prevented / y	Cost per QALY gained (€)
Reference (no vaccination)	524			-
Routine vaccination strategy only				
3, 5, 6 m + 13 m (A')	362 (–31%)	162	15	225,873
13, 15 m + 27 m (B')	391 (-25%)	133	12	250,245
15 y (C')	397 (-24%)	127	11	138,090
Routine + Booster + Catch-up strategy				
3,5,6 m+13 m +15y + C-up (D')	259 (-51%)	265	25	191,366
13,15 m+27m +15y + C-up (E')	283 (-46%)	241	22	200,503

*Quality adjusted life years

Introducing vaccination against serogroup B meningococcal disease: An economic and mathematical modelling study of potential impact

Hannah Christensen[a,*], Matthew Hickman[a], W. John Edmunds[b], Caroline L. Trotter[a,1]

Re-evaluating cost effectiveness of universal meningitis vaccination (Bexsero) in England: modelling study

Hannah Christensen *research associate*[1], Caroline L Trotter *senior lecturer*[2], Matthew Hickman *professor of public health and epidemiology*[1], W John Edmunds *professor of infectious disease modelling*[3]

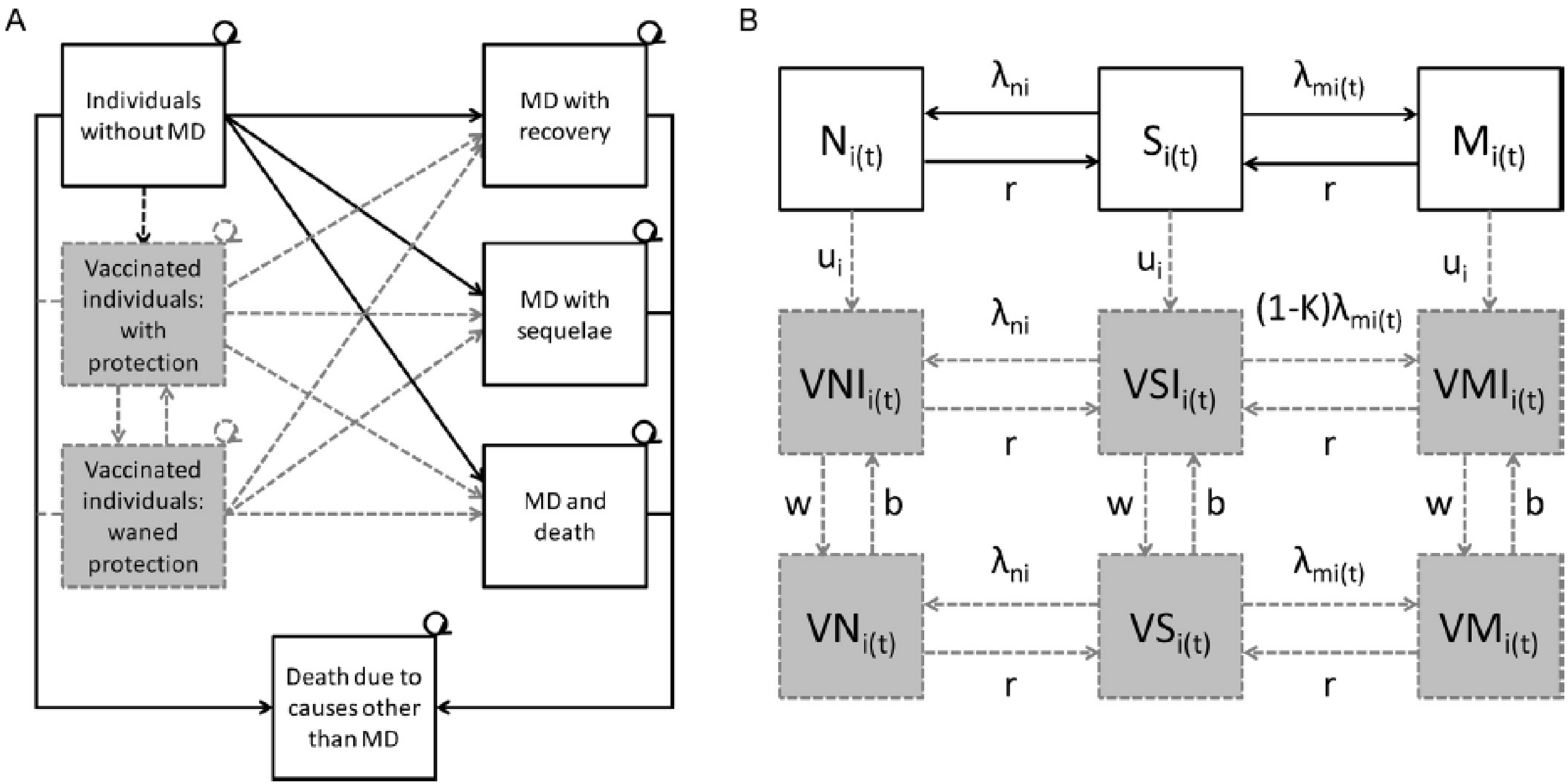


Table 5| **Results from dynamic model of cost effectiveness of vaccination (Bexsero) against meningococcal disease. Comparison of vaccination strategies (vaccination v no vaccination) assuming 0% vaccine efficacy against carriage acquisition**

Scenario description	Undiscounted: Cases averted	Undiscounted: Cases with sequelae averted	Undiscounted: Deaths averted	Undiscounted: Life years saved	Undiscounted: QALY gained	Undiscounted: Net cost of vaccination (£m)*	3.5% discounting for costs and benefits: Cost per QALY gained†	3.5% discounting for costs and benefits: Vaccine price for cost/QALY gained <£20 000	1.5% discounting for costs and benefits: Cost per QALY gained†	1.5% discounting for costs and benefits: Vaccine price for cost/QALY gained <£20 000
88% strain coverage										
2, 3, 4, and 12 months	43 783	8 843	856	41 136	140 983	19 658.8	263 100	1	181 400	5
2, 3, 4, and 12 months and 13 years	51 685	10 412	1 143	53 087	168 631	29 681.9	331 600	NP	228 500	2
66% strain coverage										
2, 3, 4, and 12 months	32 837	6 632	642	30 852	105 736	20 142.8	356 100	NP	246 800	1
2, 3, 4, and 12 months (with removal of infant meningococcal group C conjugate vaccine cost)	32 837	6 632	642	30 852	105 736	19 185.3	339 600	2	235 200	5
2, 4, and 12 months	32 542	6 573	636	30 573	104 774	14 757.3	265 700	1	183 300	5
2, 3, 4, and 12 months with 2 dose catch up in 1-4 years	33 323	6 731	651	31 518	108 171	20 467.5	358 400	NP	246 400	1
13 years	5962	1 184	217	9 008	20 850	10 100.8	927 100	NP	627 900	NP
13 years with 2 dose catch-up in 14-17 years	6150	1 221	224	9 457	21 833	10 422.9	923 800	NP	621 600	NP
2, 3, 4, and 12 months and 13 years	38 763	7 809	857	39 815	126 473	30 245.0	447 400	NP	309 400	NP
2, 4, and 12 months and 13 years	38 468	7 749	852	39 536	125511	24859.5	372 100	NP	256 800	NP
2, 3, 4, and 12 months and 13 years switching after 10 years to 2, 4, and 12 months and 13 years	38 498	7 755	852	39 583	125 670	25 397.5	394 800	NP	266 200	NP

Table 4| **Results from dynamic model of cost effectiveness of vaccination (Bexsero) against meningococcal disease. Comparison of vaccination strategies (vaccination v no vaccination) assuming 30% vaccine efficacy against carriage acquisition**

Scenario description	Undiscounted						3.5% discounting for costs and benefits		1.5% discounting for costs and benefits	
	Cases averted	Cases with sequelae averted	Deaths averted	Life years saved	QALY gained	Net cost of vaccination (£m)*	Cost (£)/QALY gained†	Vaccine price (£) for cost/QALY gained <£20 000	Cost (£)/QALY gained†	Vaccine price (£) for cost/QALY gained <£20 000
2, 3, 4, and 12 months	52 152	10 513	1 117	49 503	166 812	19 309.8	221 000	3	151 400	8
2, 3, 4, and 12 months (with removal of infant meningococcal group C conjugate vaccine cost)	52 152	10 513	1 117	49 503	166 812	18 352.3	210 500	6	144 000	11
2, 4 and 12 months	51 789	10 440	1 110	49 157	165 623	13 927.3	163 100	7	110 800	13
2, 3, 4, and 12 months with 2 dose catch up in 1-4 years	53 165	10 716	1 144	50 973	171 750	19 604.7	219 700	3	149 700	8
13 years	62 165	12 289	2 511	69 715	184 691	7946.1	104 900	14	62 100	27
13 years with 2 dose catch up in 14-17 years	64 667	12 783	2 613	73 998	196 544	8142.5	102 700	14	60 300	28
2, 3, 4, and 12 months and 13 years	91 304	18 153	3 181	100 152	285 609	28 200.3	199 000	4	131 600	9
2, 4 and 12 months and 13 years	91 118	18 116	3 178	99 953	284 931	22 810.5	163 300	6	107 300	13
2, 3, 4, and 12 months and 13 years switching after 10 years to 2, 4, and 12 months and 13 years	91 154	18 123	3 178	100 008	285 121	23 348.2	174 000	5	111 600	13

A QUADRIVALENT VACCINE AGAINST SEROGROUP B MENINGOCOCCAL DISEASE: A COST-EFFECTIVENESS STUDY

Federaal Kenniscentrum voor de Gezondheidszorg
Centre Fédéral d'Expertise des Soins de Santé
Belgian Health Care Knowledge Centre

KCE REPORT 231CS
HEALTH TECHNOLOGY ASSESSMENT

Table 5 – Cost-effectiveness of infant vaccination options, assuming no effect on carriage (compared with no vaccination)

	Cases averted (%)	Deaths averted (%)	QALYs gained[a]	Net cost of vaccination[b]	ICER: cost per QALY gained[c]
Base-case analyses – Infants vaccination at 3, 5, 6 + 12 months					
Routine	14 (10)	1 (10)	65	€15.6M	€422 700
Partly reimbursed	13 (9)	1 (9)	58	€22.3M	€663 600
Private market	5 (4)	0 (3)	23	€8.7M	€667 800
Selected scenario analyses on the routine vaccination strategy					
Increased incidence and case fatality ratios	34 (10)	2	158	€14.5M	€167 000
Higher vaccine uptake	24 (18)	1	110	26.9M	€427 400
Higher MATS coverage	15 (11)	1	70	€15.5M	€391 100
Alternative assumption for QoL loss for survivors with sequelae	14 (10)	1	115	€15.6M	€239 100
All serogroups	16 (9)	1	77	€15.5M	€355 000
Best case	71 (20)	4	284	€17.0M	€98 300

Undiscounted values, except ICER. ICER: incremental cost-effectiveness ratio. M: million. QoL: quality of life. a: QoL lost during the acute phase of the disease and for the adverse events are not included. b: additional cost of vaccination less costs averted through reduction in cases. c: discounted figures rounded to nearest 100.

Table 6 – Cost-effectiveness of infant, adolescent and combined vaccination options, assuming an effect on carriage (compared with no vaccination)

	Cases averted (%)	Deaths averted (%)	QALYs gained[a]	Net cost of vaccination[b]	ICER: cost per QALY gained[c]
Routine vaccination policy, free of charge					
Infant	1699 (12)	85 (12)	5015	€1589.5M	€260 700
Adolescent	8904 (65)	476 (65)	21353	€518.0M	€24 400
Infant + adolescent	9180 (67)	490 (67)	22596	€2151.7M	€83 000
Partly reimbursed vaccination policy					
Infant	1532 (11)	77 (11)	4525	€2252.8M	€407 500
Adolescent	5925 (43)	317 (43)	13910	€496.2M	€34 600
Infant + adolescent	6676 (49)	354 (48)	16360	€2772.3M	€146 300
Private market vaccination policy					
Infant	604 (4)	30 (4)	1788	€877.3M	€402 000
Adolescent	2090 (15)	112 (15)	4992	€198.1M	€37 700
Infant + adolescent	2592 (19)	137 (19)	6499	€1076.4M	€142 800

Undiscounted values, except ICER. ICER: incremental cost-effectiveness ratio. M: million. a: QoL lost during the acute phase of the disease and for the adverse events are not included. b: additional cost of vaccination less costs averted through reduction in cases. c: discounted figures rounded to nearest 100.

Impact of MenBvac, an outer membrane vesicle (OMV) vaccine, on the meningococcal carriage

Valérie Delbos[a,b,*], Ludovic Lemée[a,b], Jacques Bénichou[a,c], Gilles Berthelot[d], Ala-Eddine Deghmane[e], Jean-Philippe Leroy[a], Estelle Houivet[a], Eva Hong[e], Muhamed-Kheir Taha[e,1], François Caron[a,b,1], on behalf of the B14 STOP study group[2]

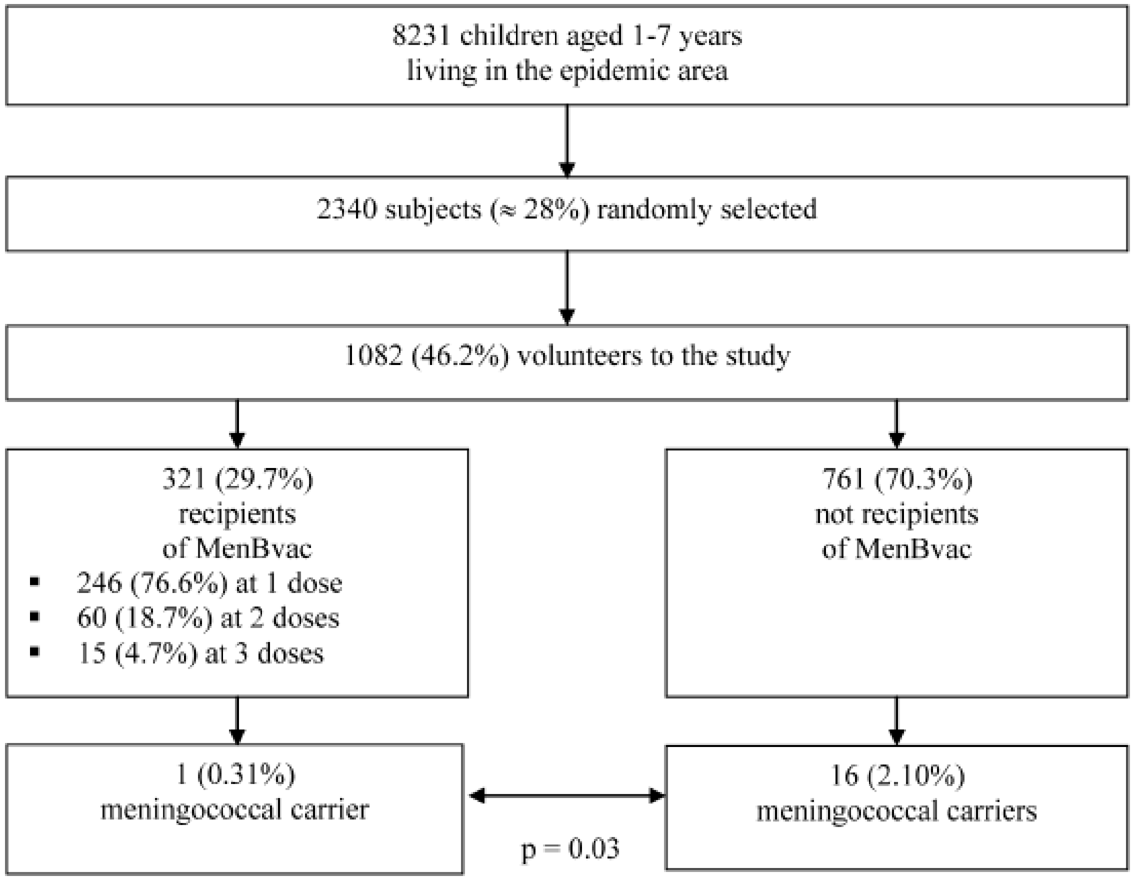


Fig. 1. Flow-chart of the study and main results.

Les difficultés

- Structure mathématique du modèle (→ propriétés: convergence, équilibre)
- Calibration, validation du modèle
- Utilisation recommandée de logiciels spécifiques (mais utilisation de feuilles de calcul possible)
- Difficulté à conduire les analyses de sensibilité probabilistes

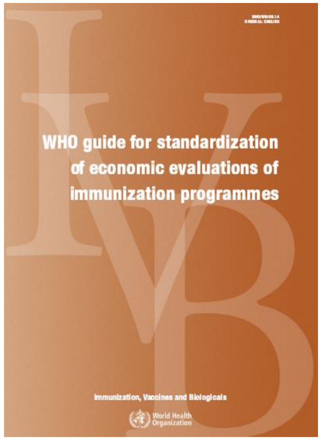


Table 8: Practical differences of static versus dynamic models for economic evaluation

	Static	Dynamic
Typical population in which costs and effects are monitored	A single ageing cohort (with removal of deaths from all causes through time)	The entire population (with introductions of births and removal of deaths from all causes through time)
Development complexity	Easy to develop, embedded in traditional health economic methods	Not part of the traditional toolbox of epidemiologists and health economists
Ready to use softwarea	Spreadsheets, e.g. MS ExcelTM (www.microsoft.com) @RiskTM (www.palisade.com) TreeAge ProTM (www.treeage.com), Crystal BallTM (www.crystalball.com)	Berkeley MadonnaTM (www.berkeleymadonna.com) Model MakerTM (www.modelkinetix.com) StellaTM (www.iseesystems.com) VensimTM (www.vensim.com)
Required data	Requires (usually age-specific) data on epidemiology, demography, course of illness, vaccine efficacy, costs	Same as with static models + average duration of infectiousness + information on relevantb mixing patterns between infectious and susceptible people

La structure d'un modèle dynamique

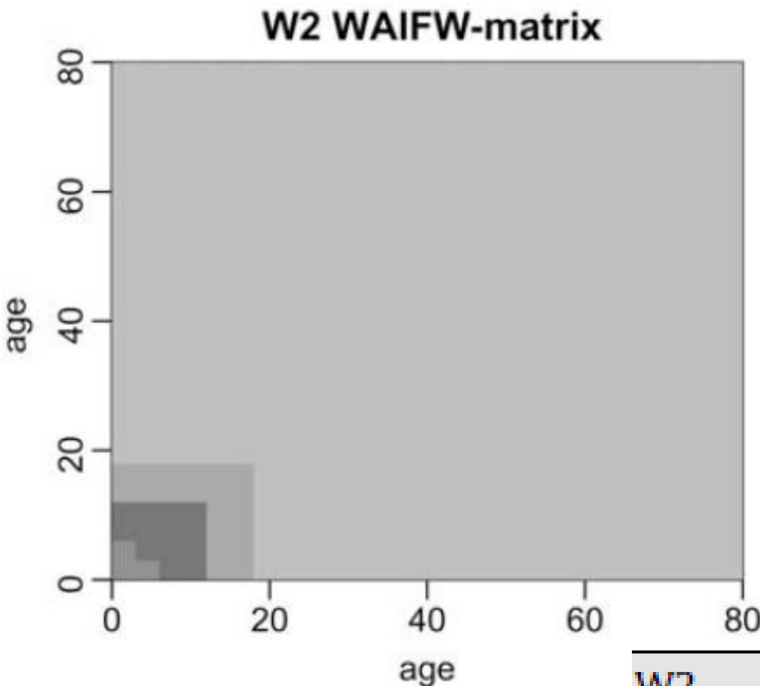
$$\frac{\partial S(a,t)}{\partial a} + \frac{\partial S(a,t)}{\partial t} = -S(a,t) \cdot \underbrace{\int_0^\infty \beta(a,a') \cdot I(a',t)\,da'}_{\lambda(a,t)} - \mu(a,t) \cdot S(a,t)$$

$$\frac{\partial L(a,t)}{\partial a} + \frac{\partial L(a,t)}{\partial t} = +S(a,t) \cdot \underbrace{\int_0^\infty \beta(a,a') \cdot I(a',t)\,da'}_{\lambda(a,t)} - \mu(a,t) \cdot L(a,t) - e(a,t) \cdot L(a,t)$$

$$\frac{\partial I(a,t)}{\partial a} + \frac{\partial I(a,t)}{\partial t} = e(a,t) \cdot L(a,t) - \mu(a,t) \cdot I(a,t) - g(a,t) \cdot I(a,t)$$

$$\frac{\partial R(a,t)}{\partial a} + \frac{\partial R(a,t)}{\partial t} = g(a,t) \cdot I(a,t) - \mu(a,t) \cdot R(a,t)$$

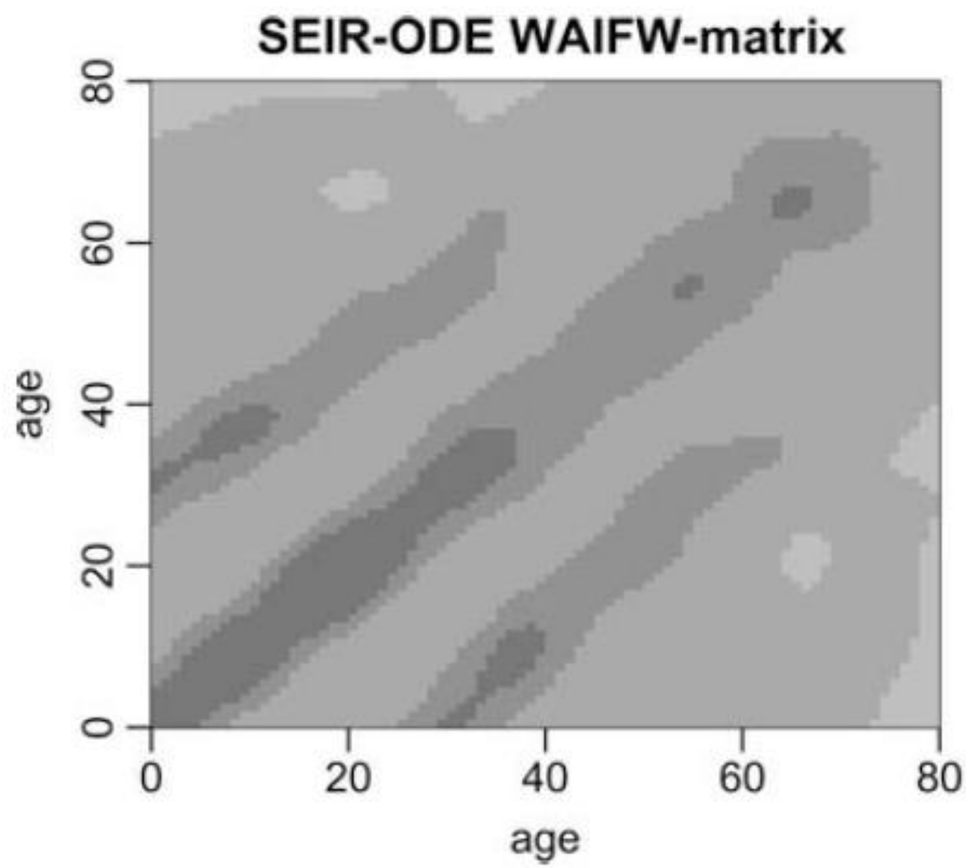
La matrice de contact (1)



W2	[0.5 3[	[3 6[	[6 12[	[12 18[	[18 26[	[26 80[
[0.5–3[	β1	β1	β3	β4	β5	β6
[3 6[	β1	β2	β3	β4	β5	β6
[6 12[	β3	β3	β3	β4	β5	β6
[12 18[	β4	β4	β4	β4	β5	β6
[18 26[	β5	β5	β5	β5	β5	β6
[26 80[	β6	β6	β6	β6	β6	β6

Ogunjimi et al. (2009)

La matrice de contact (2)



Ogunjimi et al. (2009)

Etude COMES-F (1)

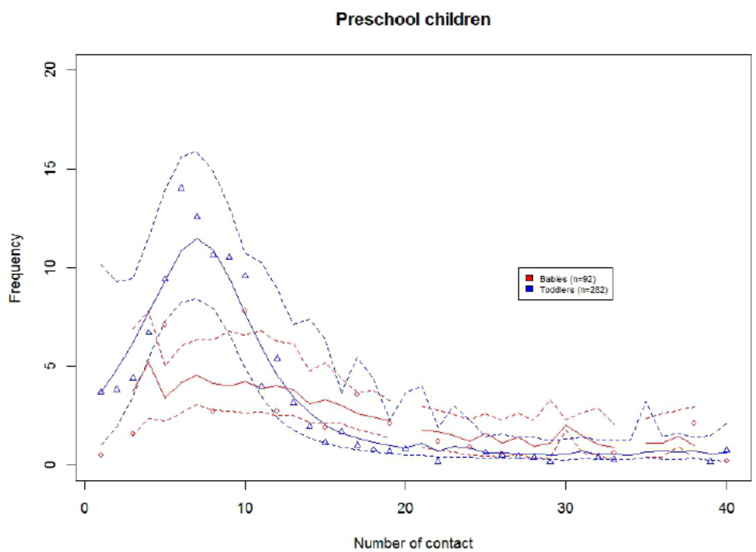
- **Rationnel/Objectif** :
  - Utilisation de plus en plus fréquente de modèles mathématiques pour l'évaluation des mesures de prévention et de contrôle des maladies transmissibles
  - Nécessité de connaître la structure des contacts au sein de la population (entre classes d'âge, entre classes de risque…) pour estimer la force de l'infection
  - Deux approches pour estimer la matrice WAIFW (« Who Acquires Infection from Whom ») :
  - La structure de la matrice est fixée a priori, les paramètres sont estimés lors de la calibration du modèle (/ données d'incidence, de séroprévalence…). Différentes structures de la matrice peuvent être successivement testées [Anderson et May (1991)]
  - La structure de la matrice est fournie par l'observation des contacts au sein de la population. La calibration du modèle permet d'estimer la(les) probabilité(s) de transmission [paramètre(s) q]

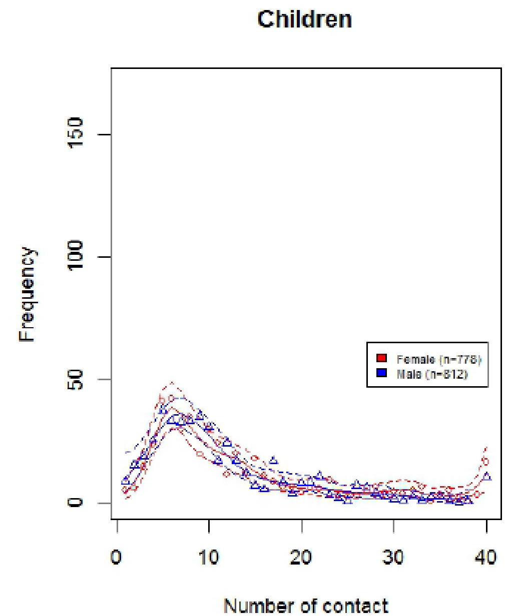
  - Etudes conduites dans de nombreux pays européens [Mossong et al. (2008)]
  - Pas de données disponibles pour la France

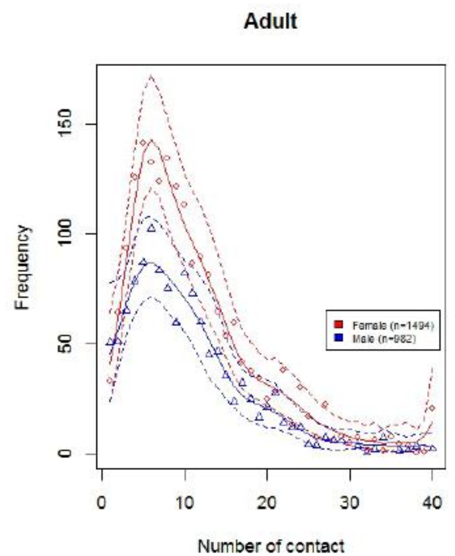
Etude COMES-F (2)

- **Résultats** :
  - Nombre moyen de contacts :
    - 9,5 / personne / jour en excluant les contacts des personnes ayant de nombreux contacts professionnels
    - 13,9 / personne / jour en prenant en compte de tous les contacts
  - Des contacts majoritairement « assortifs » avec un effet de la parentalité

Etude COMES-F (3)

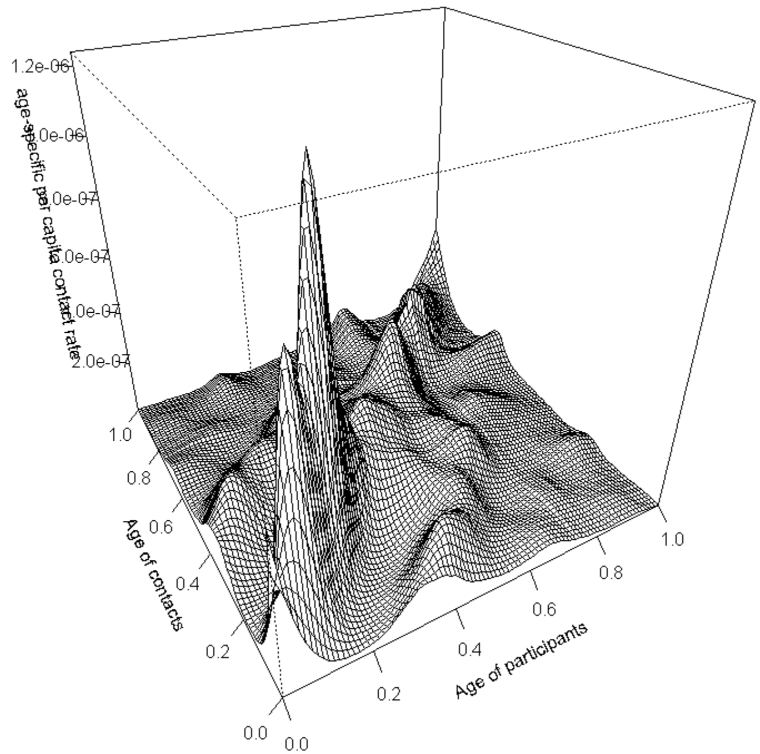


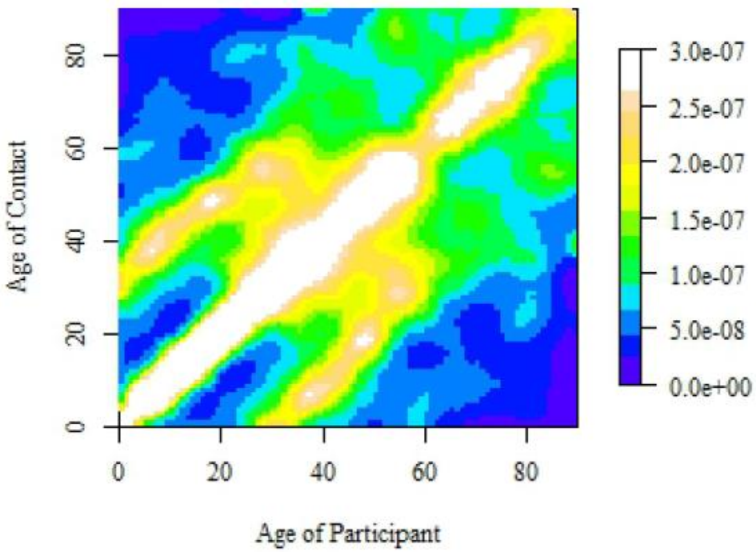




Béraud et al. (2015)

Etude COMES-F (4)





Béraud et al. (2015)

Etude COMES-F (5)

- **Résultats (suite)** :
  - Variables influençant le nombre de contacts (NRC = nombre relatif de contacts) :
    - La vague d'enquête
    - L'âge
    - Le sexe (NRC hommes : 0,92 (0,86-0,99))
    - Le moment
      - NRC week-end : 0,79 (0,73-0,86)
      - NRC vacances scolaires : 0,79 (0,74-0,84)

Béraud et al. (2015)

Merci de votre attention

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